No. 2634 VOLUME 76 FRIDAY 4 SEPTEMBER 1959

FLIGHT

AIRCRAFT, SPACECRAFT, MISSILES

Official Organ of the Royal Aero Club First Aeronautical Weekly in the World Founded 1909

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Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1; telephone Waterloo 3333. Telegrams Flightpres Sedist London. Annual subscriptions: Home £4 15s, Overseas £5. Canada and U.S.A. $15.00. Second Class Mail privileges authorized at New York, N.Y.

Branch Offices Coventry: 8-10 Corporation Street; telephone Coventry 25210. Birmingham: King Edward House, New Street, 2; telephone Midland 7191. Manchester: 260 Deansgate, 3; telephone Blackfriars 4412 or Deansgate 3595. Glasgow: 26B Renfield Street, C.2; telephone Central 1265.
New York, N.Y.: Thomas Skinner & Co. (Publishers) Ltd., 111 Broadway, 6; telephone Digby 9-1197.

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Home Fixture

THIS year has been a great one for air displays: probably the greatest ever. In April the Americans (who for some curious reason had not formerly been given to such manifestations) showed their hand at Las Vegas with a "World Congress of Flight"; and as lately as June the French presented their own *chef-d'œuvre*, the 23rd Salon International de l'Aéronautique.

These, of course, were international occasions, whereas the S.B.A.C. Display, the twentieth of which takes place at Farnborough next week, is a domestic affair. Comparisons are bound to be made, however, and we in Britain are quite content that this should be so, for Farnborough has a particular purpose and offers particular pleasure—something, in any case, that contrasts with the feverish avalanching of the Las Vegas jackpots and the stupefying sumptuousness of a Parisian banquet. This is not to suggest that there is any bogus Olde Englishe quaintness about it. Anyone who comes expecting a quiet game of croquet on the lawn is in for a jolt, though it would be apt to liken Farnborough to a thumping good game of cricket on the village green, with the local side (a hard-working lot—they knocked up a cool hundred million between January and July this year) out to catch the eye of the international selection committee while giving their home supporters some fast and fancy action.

On the teams' behalf *Flight* welcomes all comers.

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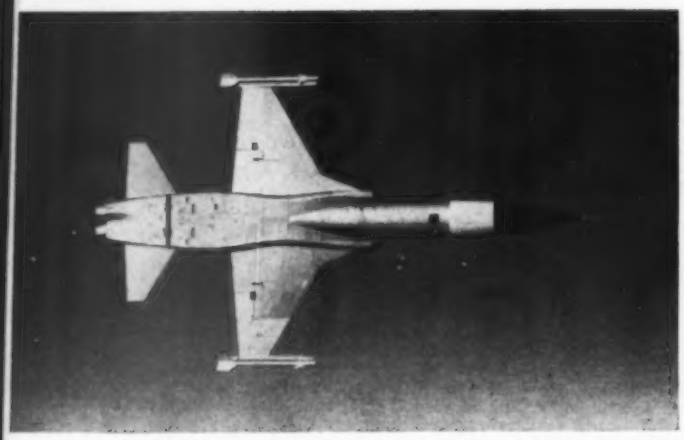


IN PLAN is seen Northrop's new N-156F Freedom Fighter, now on offer to the world's air forces, slow-rolling over California and displaying its tip-mounted Sidewinder missiles. In plan also, three Russian parachutists are seen as true comrades

FROM ALL QUARTERS

Pre-Farnborough Boom

ON the eve of Farnborough, the S.B.A.C. has announced that during the first seven months of this year the aircraft industry exported a record £100m-worth of aircraft, aero-engines, parts and components. The January-July total was £99,380,111, an increase of 10.6 per cent over last year's equivalent figure, which was itself 50 per cent over that for 1957. All this year's figures—£58.3m for aircraft, £36.6m for engines, £2.3m for electrical equipment, £1,587,663 for instruments and £462,814 for tyres—are record totals for the first seven months of any year. Leading buyers were India (£10,997,270), Switzerland (£5,768,874), West Germany (£5,349,108) and Argentina £4,435,861).

Missiles on Show

SEVERAL missiles are making first appearances in the guided weapons park at next week's S.B.A.C. Show. One is Blue Streak, the long-range weapon for which de Havilland Propellers Ltd. are prime contractors (it will be shown as a 15ft model inside the static show); another is the Short Seacat, which made its public debut at the Paris show in June; and a Bristol Siddeley Thor ramjet, powerplant of the Bloodhound, will be revealed in cutaway form. M.o.S. exhibits (as described on p. xxviii) include Black Knight—developed jointly by the R.A.E. and Saunders-Roe—and Malkara; and other missiles on Farnborough view are the Armstrong Whitworth Seaslug, Bristol/Ferranti Bloodhound, English Electric Thunderbird, two private venture anti-tank missiles—by Vickers-Armstrongs and Pye respectively, the Australian Jindivik and a D.H. Propellers Firestreak.

R.A.F. at Farnborough

FOUR Commands of the Royal Air Force are being represented in next week's flying display during the S.B.A.C. Show. Each afternoon's R.A.F. participation is to begin with a fly-past of aircraft from Bomber and Fighter Commands: three Victors from No. XV Sqn. at Cottesmore and three Vulcans from No. 230 O.C.U. at Cottesmore, followed by six Javelins collectively from Nos. 25 and 46 Sqns., both based at Waterbeach. Fighter Command is also represented by 16 Hunters of No. 111 Sqn., taking-off from Farnborough during the V-bomber fly-past, and concluding their display by executing a spectacular loop in massed formation with smoke.

All the main types of Transport Command aircraft are being exhibited: a Sycamore and Whirlwind from the Joint Experimental Helicopter Unit; a Twin Pioneer from No. 21 Sqn.; Beverley from No. 47 Sqn.; Hastings from No. 24; Comet from No. 216 and Britannia—the Command's latest acquisition—from No. 99 Sqn. Flying Training Command is represented by two Jet Provosts from the Central Flying School in synchronized aerobatics.

"Flight" photographs

Handley Page's Year

IN his review of last year's activities by Handley Page Ltd.—which celebrated its 50th anniversary on June 17 this year—the chairman, Sir Frederick Handley Page, remarks on the company's "unique position" among British aircraft constructors in having to recruit an increased labour force—because of "continued activity" at its factories. Among work in progress, chiefly on Victors for the R.A.F. and an order for three Dart Heralds for the Scottish routes of B.E.A., Sir Frederick mentions the conversion of Hastings aircraft for the training of R.A.F. bomber crews.

He refers to the absence of Government support in this country for the production of larger aircraft for civil use, which have had to be bought from the U.S.A. "Had the Ministry of Supply been empowered and provided with the necessary funds to develop civil counterparts concurrently with the large military bomber aircraft," comments Sir Frederick, "British airliners would have been available to meet British operational needs."

The Handley Page chairman refers to the Dart-Herald's "world-wide demonstration tours" and says that when the third Herald flies this month, as expected, the aircraft's trials for a full C. of A. will be flown and completed. On research, Sir Frederick makes special reference to laminar-flow techniques embodied in the H.P. 113, an executive jetliner which, he says, "will also serve as a research vehicle for demonstrating the practical feasibility of our technique for larger long-range airliners."

For 1958, profit before taxation has fallen still further to £187,241. This, Sir Frederick states, is due to the continued effect of delays in 1957 in the production and delivery of Victor aircraft owing to changes called for by the Ministry of Supply. In arriving at its profits figure the company has continued its policy of writing-off all expenditure incurred during the year on design and development of the Herald. The total written off to date amounts to £2,628,353. The chairman states that recovery of development expenditure, together with production cost (£1,106,346), is dependent on the sale of at least 80 aircraft.

CHURCH HOUSE CONGRESS: The tenth Congress of the International Astronautical Federation was opened at Church House, Westminster, on Monday last, by Mr. Aubrey Jones, Minister of Supply. On the left in this photograph is Mr. Andrew G. Haley, the I.A.F. president, and on the other side of Mr. Jones is Dr. L. R. Shepherd, chairman of the British Interplanetary Society

H.F. Tuning Breakthrough

OPERATIONAL tuning of the amplifier stages of H.F. communications radio can now be eliminated by a new method of providing wide-band amplification over the whole H.F. band. This facility has been developed by Marconi's Wireless Telegraph Co. Ltd. and incorporated in the new HS113, a 1 kW wide-band communication radio designed to provide either SSB/ISB telephony, low-level double-sideband telephony, frequency-shift telegraphy or C.W. on/off telegraphy. It will operate at any frequency, or simultaneously on a number of frequencies, at between 2 and 24 Mc/s with each frequency carrying, if desired, a number of independent channels of intelligence.

Stage-by-stage re-tuning of the H.F. amplifier whenever frequency is changed is eliminated; thus the transmitter is very simple to operate and, because there are no moving parts in the amplifier, mechanical failure is virtually impossible. Multi-valve techniques are employed, so that the failure of a valve, other than by short circuit, simply results in a slight reduction of transmitter output.

The HS113 has a distributed amplifier, a device which has never before been successfully used for amplification of this type of service. It is insensitive to the nature of the load impedance. Frequencies can be changed simply by operating a switch and the correct aerial array is automatically selected by aerial-commutation in the transmitter. The HS113, including drive, power supplies and cooling blower, is housed in a single 7ft-high cabinet.

The new technique was invented by Mr. V. O. Stokes and Mr. B. M. Sosin of Marconi. Mr. Stokes is seen at left in the picture in col. 2, with Mr. B. N. MacLarty, engineer-in-chief, and Mr. W. J. Morcom, chief transmitter engineer.

The Bacon Fuel Cell

A PROTOTYPE hydrogen-oxygen fuel cell was recently demonstrated at Cambridge. It is the culmination of 27 years of research and general development by Mr. F. T. Bacon. The present cell is the result of a two-year development contract placed with Marshall of Cambridge Electronics Ltd. by the National Research Development Corporation to prove the feasibility of the fuel cell and the reliability of its automatic control system. The prototype is the most advanced fuel cell in the world and its further development now awaits commercial exploitation.

A fuel cell is akin to an ordinary primary battery, but the electrodes are not consumed and the electrical energy is obtained directly from a natural or derived fuel which is continuously fed into the cell during operation. Briefly, the reaction (which must not be confused with combustion) is the reverse of electrolysis, but it takes place at 200 deg C and 400 lb/sq in. The prototype cell consists of a horizontal stack of forty 10in-diameter cells about 30in long and weighing about 500 lb. At present it also requires a large and heavy control system.

It is difficult to assign a definite rating to this prototype cell, for its power output is limited by the capabilities of the control system, i.e., by the maximum quantity of fuel which can be fed to the cell and the efficiency of the removal of the self-generated heat. The present cell is normally operated at 2½ kW at 24V and for one very brief occasion it has operated at 6 kW. The cell used 1 lb of fuel per kWh at an efficiency of 65 per cent, giving a running cost of 4d/kWh. This is about eight times the cost of electricity from the mains and is mainly due to the present high cost of hydrogen.

The advantages of the fuel cell are that it can take large overloads without damage; is silent and vibrationless in operation; has very few moving parts; has an "exhaust" consisting only of water; and can act as either a primary or secondary battery.

At present, however, it is an uneconomic form of generation except for special applications such as space vehicles; and, although the cell itself is slightly lighter than an equivalent traction battery, the total weight with the control gear and gas cylinders is nearly half a ton. Commercial development will no doubt overcome these disadvantages.

The first application of fuel cells would be for heavy traction, but—in, eventually, miniaturized versions—they would be eminently suitable for space vehicles. Another future application mentioned by Mr. D. Hennessey, deputy managing director of the N.R.D.C., was as an auxiliary source of power in aircraft. This application is being closely studied in the U.S.A., where the capital being invested in development programmes (under licence from Britain) is about twenty times the British investment.

IN BRIEF

It is reported that the U.S. Army fired the first Nike-Zeus high-performance surface-to-air missile on August 26. The missile was launched from White Sands and, although initially successful, the round exploded prematurely.

A memorial service for the late Claude Grahame-White is to be held at Christ Church, Down Street, London, W.1, on Wednesday, September 16, at 12 noon.

We regret to learn, as we go to press, of the death of Mr. F. H. Parker, engineering manager of Fairey Aviation Ltd. Mr. Parker, who was 45, died on August 30 after a sudden illness.

Air Chief Marshal Sir John Baker, G.B.E., K.C.B., M.C., D.F.C., R.A.F. (Retd.), who from 1953 to 1956 was Controller of Aircraft, M.o.S., has been appointed an executive director of Microcell Ltd. Another appointment in the company is that of Mr. John J. Coyle as sales manager.

Within a few days Mr. C. H. Cosmelli will be importing into this country a new Italian Falco F.8L, registration G-APUO. This attractive two-seater (subject of an air-test report by C. M. Lambert in *Flight* of June 14, 1957) will be based at Denham. Mr. Cosmelli is acting as the British representative for the manufacturers—Aviamilano Costruzioni Aeronautiche of Milan.

First shipboard firing of the U.S. Navy's fleet ballistic missile, Polaris, took place near Cape Canaveral on August 27, when a round was launched from a tube on *Compass Island*, the large surface vessel used for trials of the FBMS inertial system. After being "popped" by compressed air, the missile ignited automatically at about 50ft; all test objectives were met.

Mr. K. Fearnside, M.I.E.E., A.F.R.Ae.S., M.A.I.P., has been appointed to the board of Smiths Aircraft Instruments Ltd., as director of research. Formerly research manager at the company's Cheltenham factory, he will continue to control research activities. Mr. Fearnside joined Smiths Aviation Division in June 1953 to take charge of systems studies in their newly formed guided weapons department.

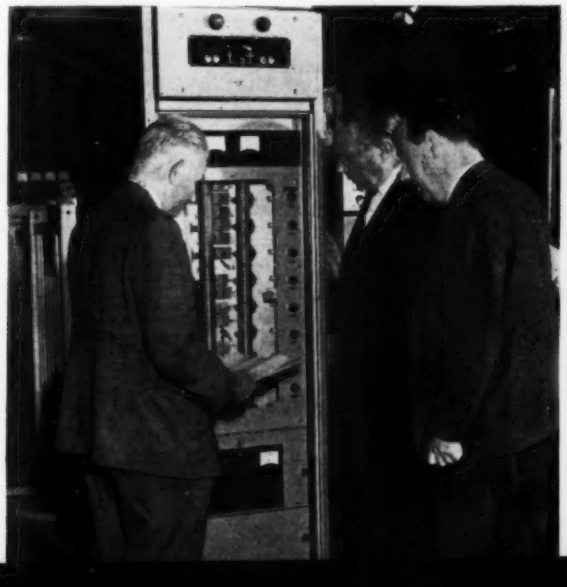
Photography enthusiasts will find much useful material in next Wednesday's (September 9) issue of *Amateur Photographer*, which is a special Enlargers and Projectors Number.

Referring to a recent paragraph (page 97, August 28), a spokesman for Sir Robert McAlpine & Sons Ltd. states that "although Aero-Enterprises (Boreham Wood) Ltd. do represent Piaggo of Genoa in this country, the Aviation Division of Sir Robert McAlpine & Sons has been appointed by Piaggio as its sole servicing and spares agent in the United Kingdom. In addition, McAlpine Aviation is an accredited sales distributor for Piaggio machines."

TWO MORE "FLIGHT" SHOW NUMBERS . . .
Sept. 11, FARNBOROUGH REPORT **Sept. 18, FARNBOROUGH REVIEW**

***SIMPLER:** Marconi engineers, at right, inspect the important new HS113 H.F. transmitter described in an accompanying news item*

***SAFER:** Mr. James Martin (left, below), managing director and chief designer of Martin-Baker Ltd., hands over to German Defence Ministry officials the first Canadair Sabre 6 fitted with the automatic Martin-Baker seat. German T-33s and, later, F-104Gs will have similar seats*



Airco D.H.121

B.E.A.'s VISCOUNT REPLACEMENT

IN last week's issue preliminary details were given of the new British short-range, 80/95-seat jet airliner ordered for service in 1964 by British European Airways. Dimensions, weights, performance, payload-range and cost-range capabilities, and a comparison with the original larger project, were given. On page 118 of this issue, in *Flight's* annual review of British aircraft, appears a further note on this important new British aircraft. Here it is possible to describe in as much detail as is permitted—and a good deal about the general design has been revealed by Airco—systems, powerplant installation, aerodynamics, payload accommodation, structure, etc.

First, a brief backward glance at the Comet 1 of almost ten years ago provides an illuminating idea of the extent to which de Havilland jet airliner design has advanced over the decade (see the following table). With the same maximum weight and approximately the same range, the 121 carries twice the payload 130 m.p.h. faster with about 35 per cent less fuel. Probably there could be no more telling illustration of the experience and continuity of D.H.'s jet airliner design team:—

D.H. JET TRANSPORT DESIGN DECADE, 1949-1959

	D.H.106 Comet 1	Airco D.H.121
Gross weight	105,000 lb	105,000 lb
Design stage length ...	1,500 st. miles	1,200 st. miles
Capacity payload	11,000 lb	21,500 lb
Fuel capacity	6,000 gal	3,840 gal
Seating capacity	36-44	79-97
Typical cruising speed ...	450 m.p.h.	585 m.p.h.

A particularly valuable asset of the D.H.121 structurally is that maximum landing weight (100,000 lb) has been set at 95 per cent of the maximum take-off weight, making available outstanding "residual range"—a new and concise expression—for faster stopping services without refuelling. A pre-requisite of the whole design has been fast turn-round, and airstairs are stowed beneath the forward passenger door and an A.P.U. provides air for starting, cabin air conditioning on the ground, and 30 kVA power.

Payload accommodation. As is customary, Airco offer a number of possible layouts on which customers can base their own requirements. Most important is the internal diameter of the fuselage (which is parallel-sided for 95 per cent of its length) of 11ft 7½in. Headroom is 6ft 8in. These dimensions permit aisle widths of 15in with six-abreast (19in wide) economy type seats, and 28in with four-abreast (23in wide) first-class seats. These dimensions are remarkably generous.

The drawing on this page illustrates the probable layout to be adopted by B.E.A., comprising 55 seats economy-class, six-abreast, and 20 seats, four-abreast first-class. Three lavatory-washrooms, one at the extreme forward end and the other two at the extreme end of the cabin, are provided, and there appears to be generous galley and coat space.

Other layouts offered are 79 seats mixed-class, 18 first (at 38in) and 61 economy (at 36in); 83 seats mixed-class (22 and 61); and an all-economy version with 97 economy seats at 36in pitch, six-abreast. This version has two lavatories and no coat space amidships, the forward lavatory being replaced by a capacious wardrobe.

Powerplant. The D.H.121 is powered by three Rolls-Royce RB.163 by-pass turbojet engines of 10,100 lb static thrust each. The economy of the RB.163 is claimed to be "outstanding in its class." The three engines are rear mounted, the third in the fuselage in what is described as "virtually an enclosed pod" to the rear of the major structure which, it is claimed, is "easily accessible." All three engines have convergent nozzles incorporating silencers and the two outers have reverse thrust.

The case for three engines is put by Airco as follows:—

"The positioning of engines at the rear of an aircraft has become widely accepted. It offers many advantages, particularly for the smaller jet aircraft. The Airco D.H.121 will have a really quiet passenger cabin. The engines themselves are well clear of the ground so avoiding the difficulties of debris ingestion and extreme vulnerability, and in addition the turbine discs are all aft of the passenger cabin. Noise damage will be negligible. The aircraft's performance generally benefits from the low drag of the clean wing and the higher maximum lift that the uninterrupted flaps afford.

"The rear layout offers the jet designer a latitude of choice between two, three and four engines not available with any other arrangement. For the Airco D.H.121, operating from a 6,000ft airfield over 1,200 statute miles at 600 m.p.h., three engines satisfy most efficiently the thrust requirements of take-off and cruise—and provide the best economics. With four engines the aircraft would be over-powered on take-off—the cruise being the critical case, while a twin engined aircraft with a heavier, more costly, wing of higher aspect ratio would be over-powered on the cruise while still critical at take-off."

Aerodynamics. The wing, because it is free of engines, has the inherent advantage of being designed primarily for optimum aerodynamic efficiency. It has a sweep angle of 35 deg and a section shaped so that this angle is aerodynamically effective along the whole span. Thus the D.H.121 has a normal operating limit Mach number of 0.875 above 24,000ft and a maximum economy speed of Mach 0.87 at 32,000ft—only 21 m.p.h. less than the maximum speed.

At the other end of the speed range, low approach speeds and exceptional landing characteristics are achieved with the aid of large double-slotted flaps, which, when deflected, also droop the leading edge. "Lift dumpers," for use on the landing run, as well as conventional air brakes, are fitted. While the latter can also be used to supplement the lift dumpers during the landing run they themselves can be supplemented in their air braking rôle either by lowering the undercarriage or by using reverse thrust in the air.

Lateral control is provided by simple divided ailerons, only the inner sections of which operate at high Mach numbers.

The tailplane is mounted high on the fin, well clear of both the wing wake and the reverse-thrust efflux. In this position it confers the necessary stability for the least area. It also acts as an end-plate to the fin, the effectiveness of which is increased for a given area and its actual dimensions reduced. The tailplane is all-moving and has a geared elevator. This type of pitch control, say Airco, "provides the only really satisfactory answer to the problems of high Mach number operation and this particular arrangement, developed on the de Havilland Sea Vixen, has given excellent results throughout the aircraft's speed range."

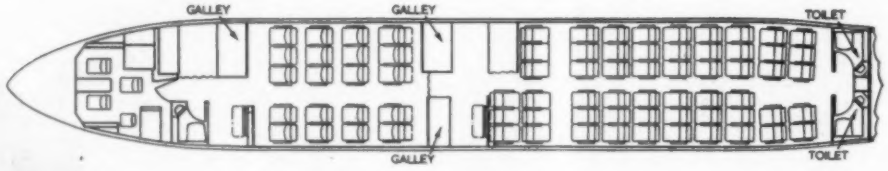
All controls are fully powered with triplicated hydraulic units placed close to the surfaces, thus making for reliability as well as eliminating both (a) the repeatability problems which can occur with finely balanced manually operated surfaces, and (b) the buzz and flutter difficulties that may arise when tab-operated controls are used at high subsonic Mach numbers.

Structure. Needless to say, the vast amount of experience gained from development of the Comet 4 structure has been utilized to the full. The primary structure of the 121 is designed with the aim of achieving a very long working life, and in addition fail-safe features, in the form of duplicated members or crack stoppers, are provided wherever practicable. Adequate "safe lives" are being achieved on those portions of structure where alternative load paths are not feasible or which are not readily inspectable.

In the main, naturally aged aluminium-copper alloys are used for all skins and stringers subject to fluctuating tensile stresses, as this type of material has the greatest resistance to fatigue and has a slow crack-propagation rate. These alloys are also less prone to the trouble associated with locked-up stress and low elongation values. Results of tests already made on portions of structure such as fuselage cut-outs have shown that when, after many years of simulated useful life, cracks have eventually occurred, the propagation rates have been very low; so they can be discovered and rectified in the course of inspection well before they begin to run. This means that long "safe life" structures are also inherently "fail safe."

Systems. A new 121 system, likely to be a customer requirement on all major airliners in years to come, might be described as "all weather operation system." Airco state categorically: "The 121 is designed ultimately to permit operations into and out of airports in zero zero weather conditions."

Engineered into the design right from the start is equipment which will permit the autopilot-coupled approach to be continued below the present minimum of about 200ft, the autopilot controlling the aircraft in pitch down to the ground and executing an automatic flare out and touchdown. Associated with this will be automatic control of approach air speed and automatic throttling back prior to touchdown. As a first stage in the programme towards fully automatic landing complete provision is made for the additional equipment required to control aircraft automatically in the rolling and yawing planes below 200ft and to kick off drift just prior to touchdown.



B.E.A.'s layout: 20 first-class, 55 economy

Straight and Level

FROM time to time I have picked out for inclusion in these columns certain aeronautical events which, in my view, qualify for the comment: "That's the most sensible thing anyone has done for years."

Here is another—a brief address by one of the delegates to the 12th Assembly of I.C.A.O., the International Civil Aviation Organization. Most of the speeches were notable for their bumbling banalities. But not that of the chief British Government delegate, Mr. M. M. V. Custance, Deputy Secretary at the M.T.C.A.

His address was brief and to the point. Its essence can be summed up in the following extract:—

"One of the most important lessons of the new jets is that we can hardly start thinking too soon about the problems of the future. . . . Technological progress is inevitable and right, but it is imperative to co-ordinate it with economic and social planning. . . . We think it is up to governments to promote a close co-ordination—at a much earlier stage than we have been able to do in the case of the jets—between governments, airport authorities, airlines and aircraft manufacturers."

* * *

At last—a responsible voice speaks out in a responsible place against the god of technological progress, excessive worship of which requires society to subsidize an airline industry which, for the most part, it still can't afford to use.

Shouldn't I.A.T.A. endorse this? It cannot want to be forever at the mercy of technology, nor can it wish for its epitaph to be: "We had to preserve our competitive position." And why don't the manufacturers speak thus? Does not economic order in the airline industry mean busy aircraft factories?

But, snorted an American publication, the British proposal was "clearly an attempt to slow down aviation progress," and "an interesting example of skilful diplomacy prevailing against the forces of logic and common sense."

If that isn't the biggest treble-think of the jet age . . .

● "NEWS FROM SCRUGGS AIRCRAFT. (*Note to Editors: Not to be released for publication before Sept. 7, opening day of the S.B.A.C. Display.*)

"A new era in world aviation history was heralded today when a giant mock-up of the magnificent new SCRUGGS 'Speedmaster' was unveiled by Lady Boost at Plane Works Road, Ponders End, headquarters of world-famous aviation pioneers SCRUGGS, members of the world-beating Super Scruggsdyne Grouponics Consortium.

"No less than two tons of Newfoundland plywood and enough Chelmsford brown paper to cover three football fields have gone into its construction. Skilled, dedicated SCRUGGS technicians completed this blue riband-snatching mock-up 'bang on schedule,' according to the firm's chairman, Sir John Blackout-Jones.

"Four thousand nails and 'enough glue to serve the needs of the total population of the Isle of Wight' went into its construction, Sir John pointed out.

"External and interior décor, in subtle Elephant Pink, Blood Orange and Boost Purple, are custom-styled by famed design consultants Ezekiel Frump (International) Associates.

"An equally magnificent custom-styled brochure, giving many other technicalities and requiring two men per copy to carry, is now being distributed on a global basis.

"*The* SCRUGGS *Speedmaster mock-up marks yet another triumph in* SCRUGGS' *acknowledged mastery of the things that really matter in world aviation.*"

● There must be quite a few airlines in the world whose inefficiency and costs are the despair of their national governments. I would recommend to them a recent report, full of sound sense and advice, which contains the following sort of passages (slightly summarized):—

"All levels of management must be made to understand that budgetary control is not just a policing system worked by the Financial Department but an essential tool of management designed to enable each unit more effectively to control its own costs.

"Cost consciousness is a matter of education. Direct personal contacts [between top management and the men in the field] are, of course, the best means of communication. If these visits can be directed specifically towards creating greater consciousness of the improvements of cost control, if the budgeted and actual expenditure of each unit was the first thing that the Head Office visitor looked at when he arrived at any base or station, and if the trends in the overall financial position of the corporation were discussed and the most recent results disclosed to local managers, a new attitude would soon develop.

"The monthly staff newspaper is also a medium which could effectively be used for the same purpose of stimulating a greater interest in financial problems and cost control."

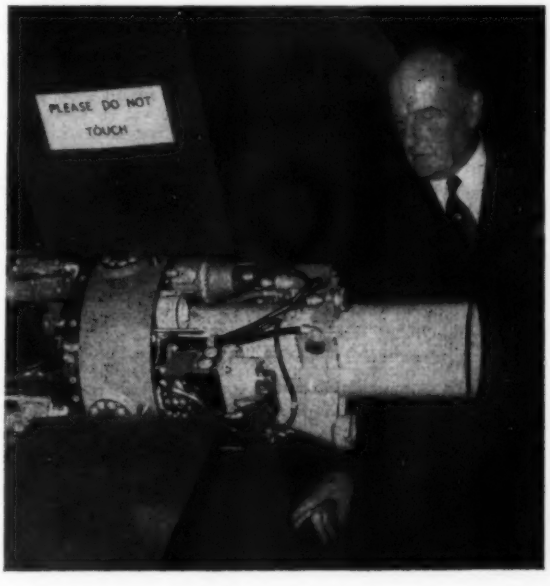
Though prepared by a special committee of inquiry appointed by the Indian Government (whose Ministry of Transport and Communications has been anxious about the mounting losses of the Indian Airlines Corporation), the report speaks the sort of language that could inspire many an airline management to improved efficiency.

● A small audio system which will feed into a pilot's earphones one of twelve tape-recorded messages when something goes wrong is being developed for the U.S.A.F. to replace the usual battery of warning lights.

"A calm yet urgent instructor's voice" will tell him what has failed and add some sage advice.

Thus we move one step closer to the realization of the Oh Crikey system which pilots specified years ago. If one engine fails on take-off, the pilot simply grabs a large striped handle marked Oh Crikey. This automatically feathers the engine, adjusts everything, and plays in the pilot's headset the words: "Oh Crikey, Oh Crikey . . ." This relieves the pilot of all action and strain.

ROGER BACON



Having tried his hand at cars, aeroplanes, balloons and bobsleighs, Lord Brabazon is evidently contemplating a personal missile. Here, nonconformist as always (see notice), he is getting the feel of the A.W.A. Seaslug's controls at the National Radio and Television Show last week. Note how stealthily he has approached the creature from a blind spot

Four Comet 4s are seen here on the assembly line in the D.H. Chester factory. Comet 4Bs for B.E.A. and Olympic are in production at Hatfield. Last week the chairman of B.E.A., Lord Douglas, said that the Corporation's 4Bs (which are being delivered in October two months ahead of schedule) would be put into general service on April 1, 1960. An initial service in October or November to Athens might be introduced. Comet 4 weight is now approved at 162,000 lb (see note below)

AIR COMMERCE

MORE PAYLOAD FURTHER

LAST week de Havilland Aircraft announced a substantial increase in the weight of the Comet 4 and its Comet 4C long-bodied variant. At present certified at 158,000 lb, these aircraft can now be operated at 162,000 lb; and this has been made possible without increasing tare weight.

The extra weight can be used to extend range with capacity payload, or it can be used to improve payload on the longer stages where, at present, payload is limited by fuel requirements.

For example, when used in the first way, the Comet 4's maximum still-air stage length, with first-class capacity payload (60 seats) and reserve fuel, goes up from 3,020 to 3,225 st. miles—an increase of 200 st. miles. The corresponding range-increase for the Comet 4C (72 first-class) is from 2,620 to 2,820 st. miles.

When used to improve fuel-limited payloads on the longer stages, the extra weight could mean that whereas the present Comet 4 with, say, 79 tourist-class seats can fly stages of up to 3,380 st. miles carrying less than its capacity payload, the new Comet will be less payload-restricted. Payload will in fact be improved on any stage between 2,800 and 3,380 st. miles and over much of this bracket the improvement would amount to 2,700 lb. The Comet 4C (92-seat tourist-class) would show to even better advantage; extra payload could be carried on stages of between 2,300 and 3,320 st. miles. As in the case of the Comet 4 the maximum additional payload is 2,700 lb.

These improvements are achieved without any increase in power, and the only performance penalty appears to be a small increase in take-off distance amounting to about 6 per cent. Because the Comet's take-off performance is already outstanding this is not likely to be a significant limitation.

DC-8 CERTIFICATED

ONE month ahead of the original target date (see *Flight*, July 5, 1957) the Douglas DC-8 (P. & W. JT3 engines) was awarded its F.A.A. type certificate on August 31. This was presented to Mr. Donald W. Douglas by the F.A.A. administrator, Mr. E. R. Queseda, at a ceremony at Friendship Airport, Washington.

The DC-8 made its first flight on May 30, 1958, two months behind schedule. The test programme has thus occupied 15 months instead of the 18 months originally planned—a remarkable achievement for an advanced transport. The first operator, United Air Lines, plans to inaugurate the first DC-8 passenger services, between New York and San Francisco, on September 18.

AEROLINEAS ARGENTINAS ACCIDENT

ONE of Aerolineas Argentinas' three Comet 4s was badly damaged on August 26 when it made a forced landing in bad weather near Asuncion, Paraguay. The aircraft was carrying 54 passengers and a crew of 11 on a flight from Buenos Aires to New York via Asuncion. The commander, Capt. S. J. Llense, was killed and an elderly woman passenger died of shock.

The possibility of salvage is being assessed; the wings and nose are reported to be badly damaged. The president of Aerolineas Argentinas, Senor Jose Guiraldes, said that the accident (the cause of which is not yet known) could have been much worse but for the "ruggedness of the Comet and the skill of the pilot."

SECOND THOUGHTS

RECONSIDERATION of B.E.A.'s 1958-59 report and accounts, which were reviewed in these columns last week, suggests that the Corporation is not as determined as had been generally supposed on extending economy-class service to Europe next year. The pertinent passage in the report reads:—

"We had hoped that it would be possible to go over completely to [economy-class service] throughout Europe in 1960. There are, however, clear indications that practical difficulties faced by other airlines—such as converting aircraft not likely to be kept in service for more than a year or so—will make difficult [implementation] of this policy in 1960."

Instead, B.E.A. propose to seek agreement at the next I.A.T.A. traffic conference, which begins at Honolulu in 18 days' time, on "substantially lower fares on holiday routes on which traffic is likely to be most responsive to reductions"—a compromise.

Not to put too fine an edge on the question, why have B.E.A. thus climbed down on their policy—first announced by Lord Douglas at the time of last year's report—to regard 1960 as the year of economy-class service in Europe? It was then said that B.E.A. had decided to prepare the way for the introduction of economy-class fares, 15 per cent below tourist fares (and replacing tourist class) in 1960. For the time being, the chairman then said, B.E.A. would "mark time" on fares. One recalls how Lord Douglas's remarks encouraged newspaper headlines like: "B.E.A. Urge Mass Travel At Cut Rates; Cut Fare Airbus Plan," etc.

Why does it now appear that B.E.A. have decided to continue marking time, despite Ministerial support for low fares *and* the fact that the Corporation's Vanguards will be ready to exploit such fares in the 1960 summer season? B.E.A.'s spokesman on these questions at a recent conference was the commercial and sales director, Mr. P. C. F. Lawton.

Mr. Lawton said that it might not be possible yet to go over completely to economy class; it was unlikely that B.E.A. would get "such a big programme through at one conference." He expected tourist differentials—34in pitch seating perhaps, and the cutting out of meals on the shorter routes. "But," he said, "it wouldn't be right to disrupt the European stage."

These remarks, unusually compromising on the eve of the annual fares contest in I.A.T.A., compare with those given in B.E.A.'s evidence last November before the Parliamentary Select Committee. The following [977: Mr. Lawton] is relevant:

"It was B.E.A.'s intention at the 1958 I.A.T.A. conference to . . . arrange a working group to sit during the year in order to bring about a satisfactory state of affairs for the introduction of economy-class services throughout Europe in 1960. We believe it is very much better to go to a conference in 1958 and ask for a working group to be set up . . . rather than go to a conference in 1959, and quite suddenly, out of the blue, ask all the airlines to face up to such an important step."

The latest development is all the more surprising when it is recalled that for the first time ever, the Minister of Transport has publicly announced that he will back the Corporations' low-fare policies in I.A.T.A. to the extent of reviewing their position in I.A.T.A. unless they get their way. In July he said:

"It is with the Government's full support that British airlines at I.A.T.A. in September will press very strongly for the adoption of economy class fares throughout the world airline structure. I hope that I.A.T.A. will agree to these fare reductions. It is the Government's view that we should achieve them in an orderly way through I.A.T.A. But I must make it plain that if our wishes are frustrated in this body we should then have to consider anew what we might do within the areas which are still under our own control. . . ."

The history of B.E.A.'s low fare policy up to publication of the latest annual report is thus as follows:

August 1958: B.E.A. said that it was preparing the way in I.A.T.A. for economy class service in Europe, about 15 per cent cheaper than tourist class for introduction 1960-61. Until then there would be a "mark time" policy.

November 1958: B.E.A. described before the Select Committee how it had raised the subject in I.A.T.A. in good time, and had achieved the setting up of a working group.

June 1959: The Minister of Transport took the unprecedented step of publicly warning I.A.T.A. of possible sanctions if the Corporations did not succeed in their advocacy of low fares.

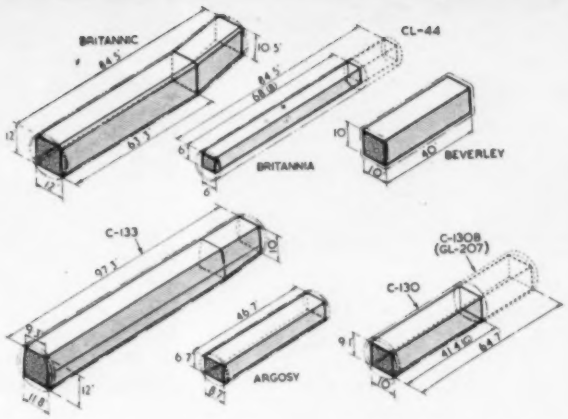
August 1959: B.E.A. suggested that their economy-fares policy might not succeed, and that compromises might emerge instead.

* * *

Is this, in fact, a climb down by B.E.A. and, if so, what is the reason for it? Certainly the answer to the first question can only be in the affirmative—though it must be recorded that B.E.A. have never expected their economy policies to succeed easily.

The fact that B.E.A. will not yet go to war in I.A.T.A. (despite the preliminary Ministerial bombardment) suggests that they see no point in jeopardizing the good relations they enjoy with their European partners. And now that four of these partners have banded themselves into Air Union it is more than ever necessary for B.E.A. to preserve these good relations. It is indeed just conceivable that it is Air Union that has contributed to B.E.A.'s decision to moderate the economy-class campaign. J. M. R.

This useful ready-reckoner of the volumetric dimensions of the main all-cargo transports was included in a recent presentation of the Short Britannic 3A (see page 107). Capacity payloads, with corresponding stage-lengths (full reserves) in parenthesis, are as follows: C-133, 90,000 lb (1,400 n.m.); Britannic, 85,000 lb (700 n.m.); GL-207, 78,000 lb (1,350 n.m.); CL-44, 65,000 lb (2,650 n.m.); Beverley, 50,000 lb (400 n.m.); C-130, 35,000 lb (1,250 n.m.); Britannia, 35,000 lb (2,500 n.m.); Argosy, 28,000 lb (300 n.m.)



AIR COMMERCE . . .

BRITANNIAS FOR TRANSCONTINENTAL

THE order book for the Bristol Britannia increased by two on August 24 when Transcontinental S.A. of Buenos Aires bought two 305s. This brings the Britannia order book to 78; Transcontinental become the sixth export (and the third Latin American) purchaser.

The Britannias involved are two of the five 305s originally built for Northeast Airlines, who cancelled their order in September 1957 due to delays in production. Two of these 305s were subsequently bought by the British independent Air Charter; only one is thus still unsold. Meanwhile, three Britannia 320s, the developed version of the 310, are being built at Filton for the shelf.

The value of Transcontinental's order has not been published. Transcontinental will use the Britannias between Buenos Aires and New York. The airline, which has three L.1049H, also has on order four Convair 880.

C.A.A.-E.A.A. AMALGAMATION?

PLANS for closer co-operation between Central African Airways and East African Airways have been mentioned in a joint statement by the chairman of C.A.A., Mr. A. E. P. Robinson, and the chairman of E.A.A., Sir Alfred Vincent. Details are to be worked out by the respective general managers, Mr. Max Stuart-Shaw and Col. M. C. P. Mostert. It seems that an "Air Union" of the two British Africa airlines is planned rather than an "S.A.S. British Africa," but amalgamation might be a long-term result.

There is already a pool between the two airlines on inter-territorial flights (Southern Rhodesia, Northern Rhodesia and Nyasaland on the one side and Kenya, Uganda, Tanganyika and Zanzibar on the other).

Mr. Stuart-Shaw has said that there is probably scope for exchange of aircraft, maintenance and sales promotion personnel. Central have Viscounts, whereas East have only Dakotas for domestic services. East have ordered Comet 4s while Central have no jet purchase plans. The matter appears to be complicated by Central's agreement with B.O.A.C. for it to operate the London - Salisbury route (with the exception of the Viscount coach-class safari services) for ten years.

NOISE AT NEW YORK

THE Port of New York Authority continues to monitor jet take-offs from its airports at La Guardia and Idlewild, and to advise the airlines concerned about their record of conformity (or otherwise) with New York's strict noise-abatement rules.

The July "score" of the number of take-offs which violated the rules was as follows: American Airlines' 707s, 86 out of 234 (36.7 per cent); T.W.A.'s 707s, 70 out of 173 (40.4 per cent); B.O.A.C.'s Comet 4s, four out of 55 (7.27 per cent).

Violations by Pan American's 707s are not available in numerical terms, but their percentage "score" was 14.6 per cent, the second best record after B.O.A.C.'s Comets.

BREVITIES

B.O.A.C. are planning to extend Britannia services to Bogota, Colombia, in January 1960 if runway conditions permit.

* * *

The second A.W.650 Argosy, G-APRL, left Birmingham last Sunday for nine weeks of tropical trials in Khartoum and Nairobi.

* * *

Zero fuel weight of the F.27 is now 35,700 lb, the same as the newly approved maximum take-off weight and maximum landing weight.

* * *

Mr. R. R. Goodison will take charge of the Aviation Safety and General Group of the M.T.C.A. in succession to Mr. C. W. Evans, who is retiring.

* * *

Bahamas Airways, now controlled by Mr. David Brown and Mr. Eric Rylands, announce the appointment of Mr. Alfred Wagstaff as sales manager.

* * *

It is announced that the electrical power system of the D.H.121 will be designed, developed and supplied by A.E.I., which concern now incorporates the interests of B.T.H.

* * *

Boeing state that the 707-320 Intercontinental, type-certificated by the F.A.A. on July 15, has met all performance guarantees made in 1955 covering range, payload, weight and fuel consumption. Empty weight is said to be 5,813 lb less than guaranteed to Pan American, and maximum placard speed limit Mach 0.9 instead of Mach 0.88.

* * *

Japan Air Lines are considering leasing from Continental Airlines a Boeing 707-120 for interim operation on the Tokyo - San Francisco route, pending delivery of their DC-8s in the spring of 1960, to meet Pan American and B.O.A.C. competition. The aircraft, it is understood, would be crewed by Continental.

* * *

An agreement was signed in Bangkok on August 24 between S.A.S. and Thai Airways whereby a new company, with S.A.S. as a minority shareholder, known as Thai Airways International, will be formed. S.A.S. will supply technical and administrative assistance and will make DC-6s or DC-6Bs available. S.A.S. crews and ground staff will be stationed in Bangkok and the Scandinavian carrier will organize a training programme.

* * *

The Handley Page Dart Herald returned to the U.K. on August 27 after a 32,000-mile tour of South America and the Caribbean. On arrival at Blackbushe it had flown 162 hours since it left on June 26. More than 1,400 South American airlines and air force representatives flew in the aircraft, orders, say H.P., are expected "when negotiations are complete and suitable credit facilities are arranged." Australasia and Africa will be toured next.

Aerolineas Argentinas, acting through Rolls-Royce, have placed an order with Heenan and Froude, Ltd., for a test plant for Avons and other engines up to 30,000 lb thrust.

* * *

B.O.A.C. will resume services to Tel Aviv, after an interval of four years, on November 1. Britannias will operate a twice-weekly return service via Geneva.

* * *

An impressive brochure on the DC-6, DC-6A and DC-6B has been published by F. B. Ayer of 250 Park Avenue, New York 17, N.Y., who are offering large numbers of DC-6-series aircraft on the used aircraft market for purchase or lease.

* * *

K.L.M. are to re-style their aircraft. The "Flying Dutchman" lettering and Dutch flag are to disappear and the tail will be painted in two-tone blue diagonal stripes with a white centre circle enclosing the initials K.L.M. On the sides of the fuselage the words "K.L.M. Royal Dutch Airlines" will replace the "De Vliegende Hollander" and "Flying Dutchman."

* * *

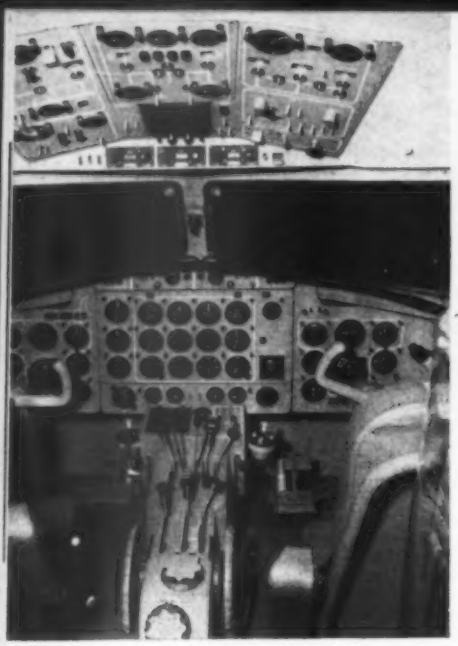
Last Friday, August 28, Pan American inaugurated the first jet services with 707-320 Intercontinentals from London over the Polar route to San Francisco. There will be two flights a week (increasing to three) with an elapsed time westbound of 13 hr 15 min compared with 24 hr previously. Pan American have since applied to the C.A.B. for direct trans Pacific jet services between New York and Tokyo, and between Chicago and Honolulu.

* * *

Chicago Helicopter Airways, which celebrated its tenth anniversary last month, has flown 72,100 helicopter hours "in complete safety" since 1949. Since passenger services started in November 1956 275,000 passengers and about 5,000,000 passenger miles have been flown. At present 20,000 passengers per month are being carried in S-58s and C.H.A. now claim to be the world's largest helicopter airline. An order for three Sikorsky S-61 25-seat helicopters was placed last June for service in 1963.

* * *

A preferential airway from London Airport for jet and turboprop aircraft using Decca was introduced for a six-month period from September 1. Known as Amber One Decca, it will be on the west side of Airway Amber One, which extends from the south coast of England towards the south-west of Scotland. Use of Amber One Decca will be limited to aircraft fitted with the Decca system. These include B.O.A.C.'s Comet 4s and Britannias and B.E.A.'s Viscounts. Aircraft without the system will be banned from using the airway. The airway, which will enable jet and turboprop aircraft to reach their best cruising heights rapidly, will be available 0800 hr to 2000 hr on Mondays to Fridays.



New shapes at Avro are the mock-up, the first prototype and the demonstration fuselage sections of the Avro 748. The metal-covered mock-up is in the foreground and the first aircraft to fly is being skinned alongside it. (Left) A stylist has been used by A. V. Roe to advise on the well-engineered cockpit. Among the points to be noticed are the individual ashtrays for each pilot and the position-indicating trim wheels

The 748 Takes Shape

PROGRESS REPORT ON A. V. ROE'S TWIN-DART TRANSPORT

WITH five months to go until February, original first-flight target for the Avro 748 (though the date is now given as "early 1960"), the prototype is taking shape at Manchester. The first fuselage is largely skinned, the majority of the wing structure is assembled and the skins are in place, and systems trial installations are proceeding within the metal-covered mock-up.

There will be twelve aircraft in the first batch, not counting two incomplete specimens that will be used for structural and fatigue testing. The first two of the twelve are prototypes and will be distinguished from production models—apart from any modifications introduced as a result of flight testing—by the position of their forward freight doors. These are on the starboard side, i.e., on the side opposite to the passenger entrance door at the rear. The change will be made so that the forward door can be used for loading and unloading passengers or freight in quick turn-rounds, for which purpose a port propeller brake, and air steps, can be provided at customer's request. Also, for Indian Air Force aircraft, the two-crew layout will be supplemented by a radio officer's position opposite the forward door and a parachute door (large enough for a jeep) replacing the passenger entry door aft.

The second aircraft—instrumented and furnished—should fly in August next year, and the fourth production model in November 1960. The first three aircraft, plus the second production machine, will be used for certification flying. About 1,000 hr (the aeroplane is simple and most of the systems have already been proved on the Viscount) will have to be completed before certification can be obtained; this should be by March 1961 and will be to both A.R.B. and F.A.A. requirements. By this time a number of aircraft should be ready for immediate delivery, and production could conceivably have reached two per month.

Plans for production of the 748 in India are as yet uncertain; an Indian mission is at present visiting A. V. Roe in order to settle outstanding questions. For example, it is not yet known how many complete aircraft, sub-assemblies or component parts would be supplied by Avro. Nor is it quite clear what arrangements are to be made by the Indian Defence Ministry (with whom Avro signed the licence-to-build agreement) for manufacture in India. It is confirmed that the factory will be at the I.A.F. Maintenance Command H.Q. at Kanpur but, contrary to expectations, it seems that Hindustan Aircraft will not necessarily be involved. If they are not, fresh sources of skilled and semi-skilled labour will have to be tapped and a new organization started from little more than some large hangars and numbers of I.A.F. engineering officers. The production of Dart engines in India is also under discussion.

Undoubtedly this Indian Defence Ministry order is a tall feather in Avro's cap. The instigator was largely Mr. Krishna Menon, the Indian Defence Minister, but Hawker Siddeley acknowledge with gratitude the Ministry of Supply assistance which they received, particularly in the later stages of negotiation. The reasons for the selection of the 748 appear to be (1) Indian confidence in the technical expertise and financial status of the Hawker Siddeley Group, with whom they have been dealing for some years in connection with Hunters, and (2) the adaptability of the simple and relatively inexpensive 748 design to manufacture in India. Handley Page, Fokker and Lockheed (the last-named offered to design a special aircraft for Indian conditions in 90 days) could hardly offer these advantages in such full measure. Avro have capped their argument by offering the 748 for £170,000 less radio or optional equipment—a price which just undercuts both competitors which have aircraft flying. The break-even figure at this price is said by Hawker Siddeley to be "75 to 100 aircraft."

Distinctions between F-27, Herald and 748 performance are fine ones, particularly when the different power units (Friendship and 748 have Rolls-Royce Dart RDa.6s, the Herald Dart RDa.7s) are taken into account. The 748 could be equipped with the more powerful engines, and design studies to this end have been undertaken. Significantly perhaps, the RDa.6 design is thought by the I.A.F. to be quite satisfactory for their needs; only when extremely high-temperature and high-altitude conditions are encountered is the extra power likely to be really important. When it is required, dihedral and fin area should remain adequate to take it, although slight stiffening of the wing will be necessary.

Some £2½m is being invested in the 748 project, and production is being tackled with vigour. Three fuselage and wing jigs are being set up (one of each is already employed in construction of the prototype) while tail units are being sub-contracted to A.W.A. and ground equipment to Gloster. (This is typical of Group interchange; the A.W.650 wings, for example, are built by Avro.)

The Avro 748 is a modern exercise in fail-safe design, very much to its makers' own ideas although Bristol and Vickers have been generous in their help and advice. Component manufacturers have been pressed to take the same commercial risks that the Group themselves must take in embarking on the project, and equipment for the first two prototypes is in general being delivered without charge. Admittedly, specially developed equipment is being avoided wherever possible, but this does not apply to the unusual Messier undercarriage; and "special arrangements" have been made with Rolls-Royce about the supply of engines. It is a sign of the times that competition for the supply of accessories has been keen.

One question that is asked of the 748 is, "How much of the design can be attributed to the Aviation Traders Accountant?" Some will claim that there is a good deal of Account influence in the 748; A. V. Roe state categorically, "There is no connection with it at all." There are obvious similarities, of course, and while Avro concede that the Accountant was a design they studied, they point out that any twin Dart, low-wing aircraft designed to give 2ft clearance for a 12ft propeller and having an unbroken wing torsion box will bear that superficial resemblance. Their argument is certainly borne out by the shape of the Grumman Gulfstream and the Japanese YS-11, and in any case the 748 stemmed from earlier studies (some of them high-wing designs) for twin Dart and twin 1,000 h.p. turboprop projects. Decisions on the final configuration were taken only after market research by a semi-independent team within the Hawker Siddeley Group.

* * *

Asked in the Indian Parliament to disclose details of the 748 agreement, Mr. Krishna Menon, Defence Minister, replied this would "not be in the public interest." "But," he said, "the terms are the most favourable which we could get from any aircraft manufacturer." The broad terms were that India would pay a licence fee spread over eight annual instalments, the first payable "only after the aircraft is certified and we are satisfied that it meets the Indian Air Force requirements." No royalty would be payable on the first 100 aircraft manufactured. The Indian Government would have the right to sell the aircraft to other countries "subject to agreed conditions."

Mr. Menon said that the aircraft would be ready "in the middle of 1960." The capital commitment was expected to be just over Rs.10m (i.e., less than £1m).

Britannic 3A

NEW FACTS ABOUT SHORTS' FORTY-TON TRUCK

AT a news conference in London last week, Sir Matthew Slattery, chairman of Short Brothers and Harland Ltd., announced new details about the Short Britannic. This big new all-cargo transport, for which an intent-to-purchase has been signified by the Minister of Defence for R.A.F. Transport Command, is now known as the 3A, and it is bigger—as well as heavier—than the Britannic 3. Span is more than 10ft greater, and length is increased by 2½ft. Gross weight remains, as previously published, at 218,000 lb, and payload likewise stays at 85,000 lb. The suffix "A" is simply applied to distinguish the new Britannic from the earlier Britannic 3, which had a gross weight of 190,000 lb and a payload of 70,000 lb.

Shorts have taken as "good enough" the Government's stated intention to order, and are proceeding with detailed design. About 350 engineers and draughtsmen are now at work on the project, a total of about £300,000 having been spent to date. The Britannic was described as "a private venture with a starting order"—an order which is expected to be for ten aircraft. Shorts expect to spread development costs, which were given as about £5.3 million, over 30 aircraft, the break-even figure.

Sir Matthew did not think that anyone "seriously supposes that the Armed Forces of this country can be made mobile with only ten aeroplanes." The complete contract was not expected to be made final for "several months yet"; but metal would soon start to be cut on the prototype.

The first Britannic 3A is expected to fly early in 1962 and to be in the hands of the R.A.F. in 1964. So far as a civil version is concerned, Sir Matthew said that he regarded the Britannic 3A as basically suitable for civil use, and Shorts were developing—and expected to have ready soon after the prototype's first flight—the "fully developed freight handling system" necessary for commercial freight carriers. A civil version could be delivered in 1965 or 1966 at a cost of £1.6m to £1.7m all-up, depending on the sort of special equipment required. Questioned about the fact that comparable American freighters will be available four or five years in advance of the Britannic, Sir Matthew replied that the Britannic 3A would be available to take full advantage of the forthcoming boom in the all-freight business. Asked whether B.O.A.C. had shown interest, Sir Matthew referred to B.O.A.C.'s evidence in the Select Committee's Report to the general effect that there was little future in all-freighting; but he felt sure that their ideas would change.

Mr. Hugh Conway, director and chief engineer of Short Brothers and Harland, outlined the development history of the project. The Britannic, he said, owed much to the Britannia though physically there was now not very much relationship. But from the development point of view a great deal was owed to the Britannia. This extended to aerodynamics, structural techniques and flying controls; and in respect of the last-named system—which was virtually the same as that of the Britannia—Mr. Conway estimated that development would be "enormously simplified." Perhaps up to a year's aerodynamic development might be saved.

Bristol were designing and manufacturing the wing, Saunders-Roe were designing the rear fuselage, and Boulton and Paul were designing the powerplant installation. A total of 2,000,000 design and engineering man-hours would be required of all the participating firms.

The wing design differed considerably from that of the Britannia, largely as a result of the change in engine centres which, with the Proteus, were set at about 12ft. The engine centres for the Tyne-powered Britannic were of the order of 20ft.

Artist's impression of the Short Britannic 3A in the uniform of Royal Air Force Transport Command

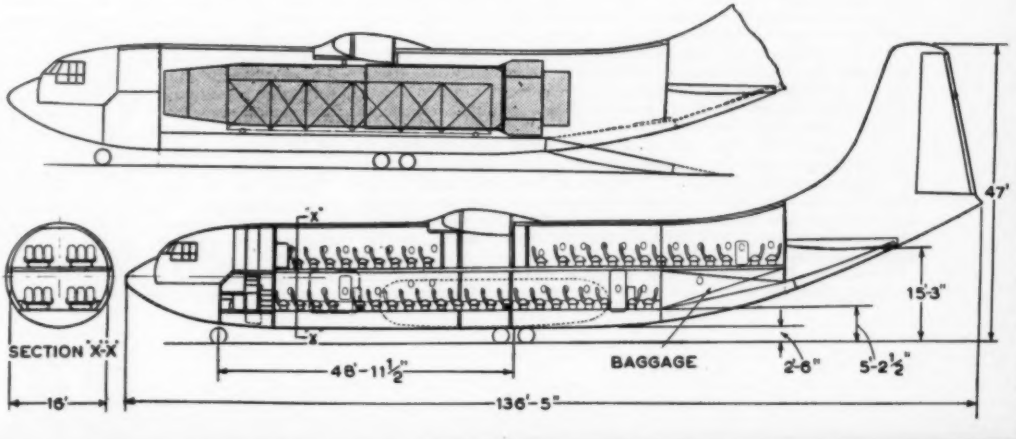
The Rolls-Royce Tyne, said Mr. Conway, was expected to be developed up to 7,000 e.h.p. [the RTy.12 of the Britannic 3A develops 5,730 e.h.p.] which, with 18ft propellers, would make possible increases in gross weight of up to 250,000 lb; increased capacity would be made possible by further lengthening the fuselage.

Roughly speaking, the fuselage was 12ft×12ft, dimensions which were compared with those of the C-133, comparative lengths of the two aircraft being respectively 84½ft and 97ft. By comparison, "the aeroplane which is very similar to our old PB.16 project" [the Argosy] measured 6ft 7in high × 8ft 7in wide, length being 46ft 7in. Comparable dimensions for the C-130 were 9ft 1in × 10ft × 41ft 4in (see diagram, page 105).

Graphs were shown illustrating payload-range performance, and Mr. Conway explained that the design requirement was for an aircraft that could carry 30,000 lb to Australia with only two intermediate stops, Aden and Singapore. A two-stop payload of 30,000 lb was guaranteed, as was a 58,000 lb payload with four stops (El Adem, Aden, Gan, Singapore). The limiting sector on the two-stop flight was Aden - Singapore, which would be done with a payload of 30,500 lb, thus setting the end-to-end payload at this figure. A payload of 59,500 lb could be carried on the Singapore - Darwin sector, and 40,000 lb on the London - Aden sector. (All these figures include full fuel reserves and 50 per cent annual headwinds.)

On Shorts' choice of the turboprop for the Britannic, Mr. Conway said: "We are absolutely convinced that low operating cost is the most important factor," and though there *might* be a case for jet speed where traffic was so high that it offset the greater cost of the extra capacity that jet speed produced, they "certainly do not believe that the jet is cheaper, especially for civil operations."

The most important aspect of the Britannic's civil operating cost statistics was, in Mr. Conway's opinion, the flatness of the cost curves over stage lengths of up to 2,500 miles. Up to this distance, from 500 miles, seat-mile direct operating costs (according to the S.B.A.C. method) were below one pence; and per ton-mile direct costs were as low as sixpence over the same sort of stage-lengths. The number of seats assumed in the pence per seat mile cost curves was not stated, but Mr. Conway indicated that maximum seating capacity of the Britannic (A.R.B. requirements about emergency exits permitting) was 255 maximum, accommodated on two decks.



These two views depict the military and civil rôles of the Britannic 3A. Top, Britain's LRBM Blue Streak can be stowed aboard; below, a maximum of 255 passengers can be accommodated on two decks — 126 six-abreast 32in pitch on top, and 129 at the same density below

Missiles and Spaceflight

THE COMMONWEALTH SYMPOSIUM

WEARING its newly acquired suit of respectability with an anxious, well-intentioned air, the British Interplanetary Society assembled high hopes and 176 participants for the first Commonwealth Spaceflight Symposium at Church House, Westminster, on Thursday of last week. In spite of an over-tight lecture programme that ran late throughout the three-day meeting, leaving little time for open discussion of the papers, the symposium succeeded in producing plenty of ideas. Of the 176 people who collectively generated these ideas, seven were from the overseas countries of the Commonwealth.

The symposium was opened officially by Sir Eric Harrison, High Commissioner for Australia, who disclosed during his remarks that £70 million had been spent to date on developing the Woomera range. Soon, he said, the total would be £100 million. The chairman of the B.I.S., Dr. L. R. Shepherd, also spoke at the opening, suggesting that this country should be spending about £20 million per year, gradually increasing to £50 million, on space research.

No fewer than seven of the 19 papers presented at the symposium were by individuals employed by member-companies of the Hawker Siddeley Group, and at a dinner party on the eve of the meeting the Group's policy on spaceflight had been outlined to scientific and air correspondents by senior officials of Hawker Siddeley Aviation. The message seemed to be that the Group and spaceflight were just good friends at present, but that a much closer relationship was anticipated (Government expenditure permitting) in the future. The Group did not know what to suggest as a firm programme to the Government, but it expected to have some ideas after the symposium.

The full list of symposium papers was given in last week's issue of *Flight*, together with points from the papers by H. R. Watson and Dr. W. F. Hilton. The subject of J. H. Thomson's paper, the Jodrell Bank radio telescope, was also the subject of a feature article in this section last week. On these pages we report extracts from the remaining papers of greatest general interest (including on page 110 the proposal by G. K. C. Pardoe of de Havilland Propellers for a spaceflight project based on Blue Streak), and from the general discussion at the conclusion of the meeting.

Britain's Place

John E. Allan, head of the aerodynamics, projects and assessment department of the weapons research division of A. V. Roe and Co., has become well known to a variety of audiences as a public speaker and writer on spaceflight subjects. His presentation at the symposium, illustrated by slides and models, was given with well-practised ease, and his written paper *Britain's Place in Interplanetary Exploration* was ambitious in scope.

Describing the possible scope of a British space programme, the paper said:—

From descriptions of world space plans, it is possible to visualize several types of programme, of increasing thoroughness and expense:—

(Minor) (1) Observation and analysis of other nations' space vehicles (e.g., Czechoslovakia);
(2) creation of scientific payloads to be carried in other nations' space vehicles (e.g., China);
(Major) (3) building and operating space vehicles for exploration (e.g., Russia); and
(4) use of spaceflight for economic or other civilian operations.

Britain now stands at stage 2, with the announced prospect of starting on stage 3 within a few years on a modest scale. Stage 4 will almost certainly become essential, but only after we have worked on stage 3 for some years.

On the subject of the organization of the programme the paper discussed the rôles of existing establishments, societies and other bodies, and went on to put forward the following comments on the proposal for a new Commonwealth Space Agency:—

It is evident that no existing single body is at present constituted to undertake this task, and hence some new creation is needed. The extent of a possible agency will depend on the level of Commonwealth activity. If it stayed as it is there seems little doubt that the Royal Society could adequately co-ordinate research in the universities, sponsor investigations, enter into official international agreements and tender scientific policy advice to the appropriate Cabinet committees.

Should the larger programme develop, however, involving industrial efforts, other types of co-ordination would clearly be needed. We have evidence of different kinds of co-ordinating agency, depending on their terms of reference, the complexity of the activity covered and the financial scale of the work. Four examples suffice: (1) Royal Society committee (e.g., Gassiot); (2) Independent research association (e.g., B.S.I.R.A.); (3) Department of Scientific and Industrial Research (e.g., Aeronautical Research Council); and (4) Atomic Energy Authority. These represent examples of agencies of increasing scope and authority.

"Flight" photograph

B.I.S. chairman Dr. L. R. Shepherd (right) and Sir Eric Harrison, Australian High Commissioner, at the opening ceremony

Further, analysis can be made of the functions of such an agency, which might embrace some or all of the following:—

Collection, collation and dissemination of information.
Sponsoring fundamental research in universities, industry and government establishments.
Preparing reviews of trends, and working data.
Submitting technical assessments to assist government policy.
Advising educational institutions of future needs.
Negotiating official international arrangements.
Planning the official space programme.
Allocating contracts in industry for vehicle construction, tracking stations, launching sites, etc.
Delegating responsibilities to existing organizations specializing in certain fields.

After discussing the commercial, military and other results of a Commonwealth spaceflight programme, the paper put forward the following conclusions:—

1. History would suggest that the Commonwealth must eventually play a full part in space exploration.
2. General technological progress requires our active participation in certain spaceflight activities which appear fruitful.
3. Economic considerations hardly justify an expensive (say £20m per annum) space programme at the moment.
4. It is recommended that the dilemma can be overcome by instituting a pilot-experiment approach to Commonwealth spaceflight activity which should not be expensive and after a period of, say, two years should ensure we would be able rapidly to exploit commercial prospects when these become available.
5. Recommendations as part of this pilot-experiment phase are: (a) The creation of a type of Spaceflight Research Association; (b) relatively inexpensive hypersonic flight experiments; (c) a Commonwealth Spaceflight Year 1960 to stimulate understanding of spaceflight and discuss possible activities; (d) emphasis on spaceflight at the 1960 British Association meeting; (e) essays at various forms of collaboration with U.S., AGARD and other bodies; and (f) professional appraisals of the numerous technical, financial and industrial problems to be resolved.
6. Ultimate objectives suggested for further study are (1) A Commonwealth Earth satellite experimental laboratory for physical, astronautical and medical work; and (2) a hypersonic very-long-range aeroplane that is fast enough to be also a satellite launcher.

Although the wide range of technical subjects covered, or attempted, at astronautics meetings has now ceased to amaze the aviation-minded onlooker, there cannot be many authors who are willing to stick their necks out and commit themselves on the financial aspects of spaceflight. This is exactly what Derek Wragge Morley, scientific correspondent of the *Financial Times*, did at the symposium, and his paper *The Economics of Spaceflight* was a serious and useful contribution, obviously based on an impressive amount of data-gathering.

At the end of his paper—or, as the author puts it, "the ends of my wanderings through a world of an all too rapidly growing field of economic uncertainties"—the following points were quoted as the main conclusions:—

Firstly, spaceflight is not beyond the reach of the Commonwealth economically in the years to come. Launching facilities are already available at Woomera, for example, which could be expanded and adapted

for spaceflight. South Africa also might be able to offer not unattractive launching areas.

Development costs are cheaper in the Commonwealth than in the U.S. by a factor of perhaps one-third, or in some cases even more. The development and production of modern jet airliners has shown this.

The development costs of a two- or three-man spaceflight project should be, present calculations indicate, similar to those of a modern jet airliner. The U.K. has developed or is developing two modern jet airliners. Therefore one 2-3 man manned space project whose costs were spread throughout the Commonwealth should not prove an excessive financial burden.

The Commonwealth has the trained manpower and the engineering facilities and combined industrial resources to carry out even relatively large experiments in this field without placing too heavy a burden on its economy, providing it acts as a Commonwealth and not as a series of poorly co-ordinated single units. Know-how in rocketry is available in the U.K. and Australia. Canada, India and Australia can all offer nuclear fuels for later more-advanced experiments. The U.K. has the third largest nuclear engineering industry in the world. The essential facilities are present.

Certain rules must, however, be rigorously followed. Firstly, cost necessitates a rigorous selection of projects. Small relatively low-cost projects to gain experience would seem to be the first choice. These could be carried out perhaps alongside very long spread-out (and therefore less costly per annum) development work on very advanced fields of especial suitability. A good example is the field of nuclear rockets. It would seem they will eventually be essential. This implies that rigorous limitation of development work on large complex projects using chemical fuels in the coming years might be economically wise.

Slow research and development work in the nuclear rocket field—while gaining some spaceflight experience—seems more profitable.

The rule of simplicity must be firmly engraven on any U.K. or Commonwealth spaceflight project. Reliability also must be a watchword. The utilization of existing facilities wherever possible—e.g., communications systems and launching or tracking bases, both Commonwealth and U.S.—should also be a maxim. . . .

Design for recoverability or re-use is also important where many flights are projected. One journey is not always cheaper than many journeys in spaceflight; both vehicle size and the number of journeys involved should be closely watched in terms of expense. Launching site location must also be watched in terms of vehicle assembly and perhaps even manufacture.

Within these limits the Commonwealth can plan. If it does so one interesting factor which may emerge may well be the growth of Australia not merely as the home of a U.K., Canadian, Indian and Commonwealth-fed spaceflight engineering industry. Australia may also become the centre for a new type of nuclear engineering industry concerned with nuclear-powered rockets. It will be, remember, wasteful to construct—and in the case of nuclear rockets to engine-test and develop—too many components of a spaceflight vehicle far away from the launching site. This applies even when frequent air transport is available when long-term planning of developments is undertaken. When the development work on a project is to be spread over many years foresight can be used to plan the programme for efficiency and economy. In this case it seems logical that money would be saved by the concentration of development work at an early stage in the area where testing, final assembly and launching must be carried out, namely in Australia.

In a paper entitled *The Performance of Nuclear Thermal Fission Rockets*, Dr. O. H. Wyatt gave a clue to one line of research followed at Langley, Bucks, by the Hawker Siddeley Nuclear Power Co. Ltd. Unlike many earlier essays on this topic, his paper included a great deal of basic calculation in order to ascertain the probable performance of rocket units in which a thermal fission reactor is employed for heating the propellants directly.

The fuels selected for study were U-235 and Pu-239, with graphite moderation. Assuming 50 per cent voidage and a peak graphite surface temperature of 2,500 deg C, it was shown that specific impulses of 675 and 325 could be achieved with hydrogen and ammonia, respectively, at a maximum working-fluid temperature of 2,000 deg C. Dr. Wyatt went on to assess the weights, calculate the burn-out velocities and describe suitable trajectories. Altogether his conclusions were that, as at present visualized, a nuclear rocket using hydrogen propellant would be as good as, or better than, future chemical rockets; using ammonia its performance would fall between that of present and future chemical rockets. Since nuclear rockets inevitably have relatively low mass ratios, their performance *vis-à-vis* chemical rockets improves at larger payloads.

The first technical paper to be presented at the Commonwealth meeting was by W. T. Fisher of Bristol-Aerojet Ltd. (left), who spoke on "Altitude Sounding by Solid Propellant Rockets and its Economics"

"Flight" photograph

Presenting in the absence of the authors of the paper *Canadian Facilities* by Dr. P. A. Lapp and A. E. Maine of de Havilland Aircraft of Canada, Mr. E. Wall gave details of the Canadian space research committee. Formed in June of this year, the Associate Committee on Space Research was jointly organized by the National Research Council and the Defence Research Board. Under the chairmanship of Dr. D. C. Rose of N.R.C., this group has co-ordination duties and will advise on international co-operation. Scientific subjects to be studied include geomagnetism, the aurora, meteorology, cosmic rays, radiation from the sun and the chemical composition of the upper atmosphere.

The Canadian/U.S. joint satellite project also was described by Mr. Wall. The U.S. National Aeronautics and Space Administration had recently accepted proposals by D.R.B. for joint experiments, and a satellite instrumented by Canadian scientists from the Defence Research Telecommunications Establishment was to be launched "some time after 1960" from Vandenberg Air Force Base, California. The satellite "will permit probing by radio pulses of the ionosphere's upper side. The vehicle will pursue a polar orbit and will direct pulses downward. This will be reflected back to the satellite and the information will be telemetered to ground stations."

As well as this satellite, two high-altitude research rockets will be instrumented by DRTE and launched by NASA. These experiments, which will take place later this year, are designed to study the electron density in the ionosphere.

An interesting possibility was put forward in the conclusion to the Canadian paper. "It has been found that the intensity of the recently discovered Van Allen radiation belts decreases considerably in the region of the Earth's magnetic poles, and for this reason it may be inferred that a launching site for manned space journeys located in Canada's remote northlands might prove to be very advantageous. As a corollary to this, the vast territories in the north of the country, far away from population centres, would seem to favour the location of a large launching complex from a safety point of view. A near-polar site could be of great importance to astronautics and the matter seems worth careful examination . . ."

Final Discussion

The chairman of the concluding session of the meeting, Dr. Hilton, posed three questions as the basis for the final general discussion: were we any nearer to British action towards a real spaceflight programme, should the Commonwealth act as a unit in this field, and where should British launching sites be located?

The third of these questions received the obvious answer from H. J. Higgs of the Weapons Research Establishment, Australian Ministry of Supply, who earlier in the symposium had presented *Some Remarks on Woomera as a Space-vehicle Tracking and Launching Station.* Mr. Higgs said he agreed with the suggestion of a joint Commonwealth space authority; the organization of NASA might provide a useful guide.

M. J. Brennan of Vickers-Armstrongs (Aircraft) and formerly of Saunders-Roe said that 20-30 lb satellites could be launched immediately, at very little expense, by using Black Knight as a first-stage booster. G. K. C. Pardoe of de Havilland Propellers suggested that the B.I.S. could follow-up the symposium by summarizing the full extent of British work which could be considered as part of an integrated space programme. Another speaker suggested that each country in the Commonwealth should be given responsibility for a specific part of the launching vehicle and satellite, after the Society had examined existing facilities and persuaded the appropriate governments to put money into a joint project.

Summing up on behalf of the British Interplanetary Society, Dr. Shepherd made two main announcements. The society would organize a second Commonwealth symposium, he said, probably in 1961; and a joint panel would be formed to summarize the feeling of this meeting and to decide what future plans should be made. Industry and Commonwealth-country representatives would be included in the panel membership.

The Commonwealth symposium, Dr. Shepherd commented, had received little support from the Ministry of Supply (although the Ministry representation at the I.A.F. Congress was strong), but the society was delighted with the British industry attendance. It was obvious, the chairman submitted, that a spaceflight project based on Blue Streak and Black Knight, as outlined in the Pardoe paper, would in fact be carried out, simply because this country would have the hardware. He agreed with the suggestion of a Commonwealth space agency; some such organization would have to be established.

Earlier in the symposium Dr. Hilton had given an analysis of the attendance at the meeting which showed that there were 14 participants from foreign countries present. As a footnote to our report of the meeting it is perhaps of interest to note that the 14 included four from the Israeli Ministry of Defence, two from the Soviet Embassy, and one from the headquarters of Strategic Air Command at Offutt Air Force Base, Omaha.

KENNETH OWEN

Missiles and Spaceflight . . .

TO SPACE BY BLUE STREAK

ONE of the most informative papers presented to the Commonwealth Spaceflight Symposium, which met in London last week, was written by G. K. C. Pardoe, Chief Co-ordinator (Ballistic Missiles) of de Havilland Propellers Ltd., and entitled *General Review of a British Spaceflight Programme Based on Blue Streak*. It outlined a number of valuable types of mission, particularly of the orbital variety, which could be accomplished by devices launched initially by a first-stage based upon a Blue Streak long-range ballistic missile (photograph above).

At the outset Mr. Pardoe emphasized his intention of presenting as broad and comprehensive a review as possible; moreover, he stressed the impracticability of planning any spaceflight programme without careful study of the past achievements and future intentions of the U.S.A. and Russia. After briefly recapitulating the present space situation, and producing telling arguments in support of a national space programme (for any country), he dwelt upon the awesome cost involved in any spaceflight system (which inevitably included far more than just a vehicle), and suggested co-operation throughout the Commonwealth with a view to producing an integrated system, including launching sites and tracking devices favourably disposed throughout the globe.

Turning to consideration of desirable objectives Mr. Pardoe suggested concentration upon orbits essentially within that of the Moon, the lowest being perhaps 50 miles up and the highest being a very elliptical orbit encompassing the Moon. From the military viewpoint orbits between 50 and 150 miles might be particularly suitable for various types of surveillance, although some form of propulsion system might be required to sustain such an orbit, making for a limited duration. Between 150 and 450 miles resolution would be poorer, although the fact that atmospheric drag would be virtually zero should enable such an orbit to be sustained indefinitely. At higher altitudes out to about 22,000 miles (the approximate height for a 24 hr orbit) military applications appeared doubtful, but scientific and commercial functions could be extensive.

After underlining the necessity of providing a properly integrated system for each type of vehicle, and drawing comfort from the fact that the major part of the equipment required for the first stage would already be in existence as a result of the Blue Streak military project, Mr. Pardoe went on to talk in general terms of the performance which would be required depending on the orbit chosen (within the limits specified above). For the lower orbits about 25,000ft/sec would be adequate, but for the outermost orbits the total velocity requirement for the complete vehicle would be of the order of 37,000ft/sec. Although comprehensive instrumentation could be packaged within a total weight of 150 lb, a payload of some 500 lb was desirable from the viewpoint of forward planning. Improved reliability, endurance and further information might call for weights of the order of 1,500 lb; moreover, the latter was likely to be the minimum for a capsule containing a man. It could be shown that approximately 2,000 lb would probably be the upper limit which could be sent into space using the existing Blue Streak as a first stage; therefore, within the present objectives, it was not reasonable to consider manned missions.

Aiming at an initial simple mission, Mr. Pardoe first outlined the potential of Blue Streak carrying a rudimentary solid-propellant second stage. The latter comprised twin motors carrying a payload divided between two canisters located between the motors (right). In order to reduce drag and kinetic heating during the ascent, the complete payload was shrouded beneath a light fairing, which could be jettisoned either at first-stage burnout or on leaving the atmosphere. Such a vehicle would be restricted to lower orbits; and it was suggested that, in view of the simplicity of the second stage, it should be placed in orbit under the guidance of the first stage, coupled with stabilization of the second stage by rotation effected by canting the motor nozzles. If desired, the payload could finally be separated by a small H.T.P. rocket, in order to effect vernier adjustment of axial velocity (and possibly attitude) after second-stage burnout. The beauty of the overall system was that, with virtually no mechanical or system changes to Blue Streak, the latter, together with an extremely simple second stage based on equipment already under development, could place a payload of some 1,000 lb in a 300-mile circular orbit.

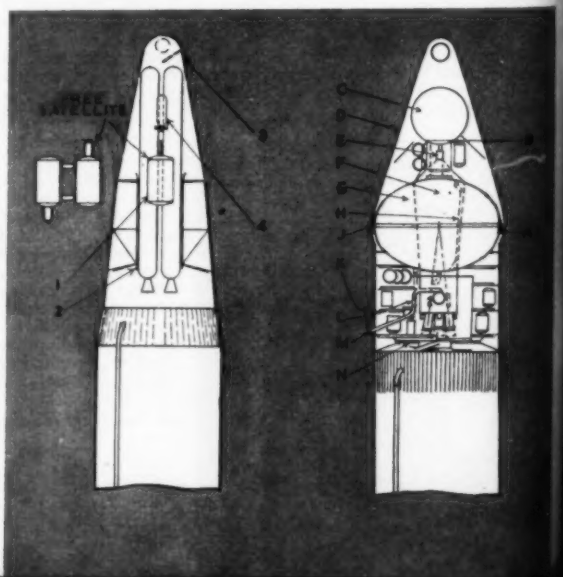
Still adhering to the theme of availability, the author next turned to the obvious combination of Blue Streak with Black Knight. This had the advantage of using highly developed equipment, Black Knight having demonstrated a remarkably high state of reliability. Carriage of so slender a vehicle sitting on top of Blue Streak would necessitate careful design of the inter-stage adaptor; obviously new dynamic bending loads in the forward tank section of Blue Streak might demand structural modification, and revised flexural characteristics during first-stage burning might involve changes in the autopilot system and larger excursion angles of the first-stage motors. Moreover, the H.T.P. tank of the Black Knight would be directly exposed to kinetic heating and, although the problem with H.T.P. was milder than with other oxidants, an attitude-control might be required to reduce radiation heat from the sun while the vehicle was in a transfer or parking orbit. Clearly it would be possible to effect substantial improvements over the basic Black Knight, and a very attractive solution combining the best of both worlds might be to retain the complete propulsion bay of Black Knight [Bristol Siddeley Gamma engine—Ed.] together with an accurate and reliable control system.

Below, right, is illustrated a suggested second stage based upon this propulsion bay, but with entirely new tankage in the form of two hemispherical domes separated by a parallel section of tank determined by the limiting volume or weight which could be lifted by Blue Streak. The author went into some detail in describing this complete second stage, and showed that an inertial guidance system could be located in a transition bay in front of the upper tank of the Blue Streak. Altogether, the second stage could well be lighter than a longer structure. Thrust/weight ratio at the beginning of second-stage ignition might be 0.8 or even less, implying a second-stage weight of at least 22,000 lb. Thus a payload of some 7,000 lb could be placed in a 300-mile circular orbit, or roughly double the weight which could be handled by an unmodified Black Knight.

Having studied three technically attractive concepts (Blue Streak associated with a simple solid second stage, a basically unmodified Blue Streak, and the new device shown below) it was essential to investigate such basic factors as technical capability, organization, finance and timing. Regarding the time-scale of Blue Streak, security allowed Mr. Pardoe only to suggest that the first flight-trial of the system "cannot be far away in the future." A major military project of this nature could not suffer in order to enable a purely scientific project to go ahead—although this situation could be reversed if primary military spaceflight objectives became apparent. It appeared, therefore, that we were some two to three years from the time at which the projects proposed might materialize. Regarding cost, it should be borne in mind that the entire concept discussed involved minimum modification to equipment already in use; and it could be shown that the additional expenditure was comparatively small and reasonable "bearing in mind the implications to the future of our country."

In conclusion, Mr. Pardoe said, "The existence of Blue Streak as a potential main stage vehicle for European countries is significant. European nations who do not possess a main stage booster facility, could well consider planning a programme using Blue Streak as their booster for either their upper stages or payload, since the design team of the vehicle would be on their doorstep.

"Earlier in this paper, an attempt has been made to demonstrate that we as a nation are bound to embark on space flight at some time. In the time-scale which I have discussed, we would be 4 to 5 years late in our early experience of these new things—this must surely be relatively unimportant when we look back in 50 years' time to the present age. What does seem vitally important is that, as a nation, and as individuals, we should have a firm plan and conception now of where we are going, and what we can do."



From Mr. Pardoe's paper, these diagrams illustrate the simple solid-propellant second stage and (for right) the modified Black Knight. 1, dual package powered by twin solid motors; 2, launch rails; 3, nosecone ejected in two halves; 4, two attitude correctors and spin stabilizers; A, separation line; B, final separation; C, payload, 53.4 cu ft; D, nosecone ejected in halves; E, ground connections and release; F, kerosine tank; G, H.T.P. tank; H, service tube through inner tank; J, external frame with release mechanism and fairing; K, electrical ground connectors; L, second-stage probe separation; M, ground connectors for propellants (H.T.P. shown); N, work platform

Britain's Aircraft Industry 1959

IN the following 39 pages we review the current products of the great industry which this journal is proud to serve. In doing so we comment upon each programme in turn, and this task is a relatively straightforward one. On this introductory page, however, some views are offered on the state of the industry itself, and to do this objectively is to invite dissension from several quarters.

To many outsiders Britain's aircraft industry appears to be a sick industry. Ever since the notorious 1957 White Paper on Defence a policy of "rationalization," contraction, and the belief that the industry has in recent years been artificially inflated, has not wanted for adherents —who have been led by the Minister of Supply himself. Already many firms have diminished in stature, and in most cases this has been the inevitable consequence of a calculated policy on the part of Whitehall customers.

Yet an entirely different, and much rosier, picture is presented by the industry's trading results. These show that at the present time the industry is exporting at a higher rate than ever before. Month after month all records are smashed and it seems likely that the value of British aviation products sent to overseas customers during 1959 will handsomely exceed £175,000,000. To lend emphasis to this figure it may be recalled that during 1946/58 inclusive aggregate aviation exports were £875m (an average of £67m p.a.) and well over half of this total was earned since 1955. Moreover, our aircraft industry is earning overseas currency at the annual rate of £3.4 per head of our population—a figure which cannot be approached by any other country in the world.

In fact, of course, the health of the industry cannot be judged by symptoms representative of extremes: whatever the man in the front office may proclaim and whatever his counterpart on the shop floor may fear, the fact remains that virtually every company within the industry today commands a position of genuine strength which it has never before known. No longer is the industry entirely dependent upon Government sponsorship of new projects and Government bulk purchase of its products. By a sometimes painful process, known as diversification, most companies have insured themselves against the disaster which can befall anyone with all his eggs in one basket; while an overdue process of streamlining—by better business administration, readier acceptance of new techniques and a healthier mentality created by the spur of true competition—is progressively increasing the ability of most British aircraft firms to compete on level terms with their commercial rivals.

Most of our larger companies reap the benefit of good direction from the top; and, what is perhaps even more important, the policymaking at the Ministries of Defence and Supply and within the three Services is notably better than in former times. These facts, acting upon an industry which has rigorously shed its excess fat, bid fair to enable the members of the S.B.A.C. to meet their competitors in timing, price and quality. On such a basis, our supposed native ingenuity and undoubted engineering excellence can hardly fail to bring about a more stable and resilient industry, and one wherein morale and pride of achievement are less affected by military exigencies and commercial fickleness.

Armstrong Whitworth Sea Hawk FGA.6

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

Baginton, nr. Coventry. Telephone: Tollbar 2261

Sea Hawk Originally a Hawker design, this aircraft is the standard carrier-borne day fighter/bomber in the Fleet Air Arm, the Royal Dutch Navy and the German Navy, the German version being characterized by a redesigned vertical tail. Powered by a Rolls-Royce Nene turbojet the Sea Hawk has a fixed armament of four 20 mm guns and can carry 75-gal tanks, bombs or rockets on three pylons under each wing. A representative load would include two 75-gal tanks inboard, two 500 lb bombs and either two tiers of two 60 lb rockets or two tiers of three 3in rockets. All recent variants have powered ailerons. With the latest Nene giving 5,400 lb thrust the Sea Hawk has in several respects proved superior to comparable swept-wing types.

AW.650 Argosy This latest product of Britain's civil aircraft industry flew for the first time in January 1959, and is making its first appearance at an S.B.A.C. Display. Five are now flying, and have amassed about 400 hours on test to date.

The Hawker Siddeley Group, of which A.W.A. are a part, launched the Argosy in 1956 as a private £10m venture, the first Group entry into the civil market. It was intended to fulfil a rôle for which no other aircraft has been designed—fast, medium-range, medium capacity freighting, with a general layout (and detail design) aimed at high-speed loading, and with pressurization and turboprop power in the form of four well proven Rolls-Royce Darts.

The Argosy remains unique in its class, and a number of provisional orders have been placed, including one for four (deposit paid) from the U.S. all-cargo carrier Riddle, for the replacement of C-46s and DC-6As (basically "adapted" cargo types whose widespread activities typify the Argosy's potential world market). Letters-of-intent to purchase Argosies are already estimated to cover the production of 40 aircraft in the next year, in addition to an R.A.F. order for the military version (AW.660—see below).

The essential feature of the Argosy is that it has a big capacity fuselage which can be loaded and unloaded from truck-bed height (4ft) via a swing-tail and a swing-nose. Among the detail features designed to expedite loading, hence cutting down manual labour costs and non-productive time on the ground, are pallets, built-in conveyer rollers ("Rollermat") and quick-release lashing points.

Target-date for certification of the Argosy is March 1960. Tropical trials, to be performed by the second Argosy, are due to be in progress in Khartoum and Nairobi as this issue of *Flight* appears. The aircraft will be away for about eight weeks and the trials involve a programme of about 200 hr. Cold-weather trials, probably in Canada, will be carried out later.

The extensive structural test programme is well advanced, two virtually complete airframes having been used. Tails and booms have been taken up to 100 per cent of critical design load; wings have so far been up to 85 per cent. About 5,000 hr of fatigue-testing has been accomplished so far; the target is 150,000 hr.

Ten aircraft are being built in order to reduce the so-called "lead-time," and to permit deliveries to be made (as in the case of Riddle) in advance of certification for the purposes of route-proving and training. Basic price of the Argosy is quoted at about £460,000.

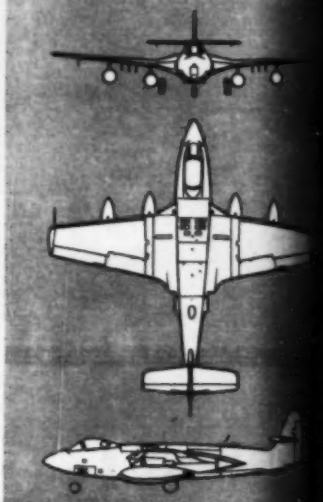
Though the Argosy is primarily a freighter, it is being marketed in full awareness that not all freight is carried by specialist cargo operators; indeed, the majority of the world's freight ton-mileage is still carried in the holds of passenger aircraft. Thus the Argosy is offered as a "convertible," and accommodation for more than 80 passengers (at almost Viscount speed and comfort) is available. However, unlike the classic convertibles of the past—C-46, DC-6A, L.1049H, etc.—the Argosy is designed essentially for freighting (with all that this implies in the reduction of costs) and is not a modified passenger airliner.

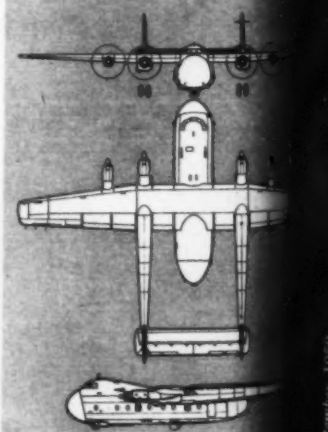
With a maximum payload of 27,000 lb the Argosy has a range of 650-700 st. miles; with maximum fuel (3,300 Imp. gal) and a payload of 8,200 lb range is 2,750 st. m.

Powerplant is the Rolls-Royce Dart 526 (RDa.7) of 2,100 e.h.p., driving a Rotol propeller; the complete package is virtually identical to that in the Viscount 810-series.

AW.660 To be built on the same Hawker Siddeley Group production lines as the Argosy (with assembly at A.W.A.'s Baginton, Coventry, factory), the AW.660 is the military version. Royal Air Force Transport Command are likely to be equipped with a squadron in 1961-62, the provisional M. of S. order (due to be confirmed shortly) being unofficially reported as more than 20 aircraft. An external difference is the modified contour of the rear fuselage, presumably made to accommodate large weapons. A special tail ramp-door permits air-dropping to be carried out.

AW.670 Airbus A project only, the Airbus is a variant which carries a completely new, extra-large-capacity unpressurized fuselage for car ferry work (six cars). For short-range, high-density routes, the Airbus can accommodate 126 passengers.





Argosy

Auster Workmaster

AUSTER AIRCRAFT LTD.

Rearsby Aerodrome, nr. Leicester. Telephone: Rearsby 321

This year's range of Auster light aeroplanes includes six commercial machines. Most recent is the **Workmaster**, powered by a Lycoming O-360FA engine of 180 h.p., which has now given proof of excellent performance, particularly in landing and take-off from Alpine glaciers and tropical fields; it can be equipped for agricultural, ambulance and freighting. Popular for sport and training use is the **Aiglet**, which is fully aerobatic and powered by a D.H. Gipsy Major 10/2 of 145 h.p. The specialized agricultural **Agricola**, a low-wing machine, is powered by a 240 h.p. Continental engine. The military **AOP.9**, produced for both British and Indian armies, has the Blackburn Bombardier of 173-200 h.p. Fitted with a 130 h.p. Gipsy Major, the **Alpha** can be supplied as a general-purpose sprayer fitted with Britten-Norman spray gear. Largest of the civil Austers is the **Autocar** four-seater which has a Gipsy Major 10/2.

A. V. ROE & CO. LTD.

Greengate, Middleton, Manchester. Telephone: Failsworth 2020

Avro 748 Only a tentative project at the 1958 S.B.A.C. Display, the 748 is a new twin-Dart transport that has subsequently been announced (in January 1959) and—more important—ordered. The Indian Government signed in July a contract with the Hawker Siddeley Group for a licence to manufacture the 748 for the Indian Air Force, which has a very large number (reported to be approximately 100) of Dakotas to replace.

The 748 is the third twin-Dart contender for the DC-3 replacement market; it differs primarily from the Dart Herald and the Friendship in its low wing layout. It is also expected to sell at a lower price (£170,000). Passenger capacity is 40-44, and capacity payload is 9,666 lb. Range with this payload (no reserves) is 665 st. miles; range with full tanks (1,100 Imp. gal) is 1,870 st. miles, corresponding payload being 4,420 lb. An important feature of the structure is that it is claimed to be designed from the outset to be fully fail-safe.

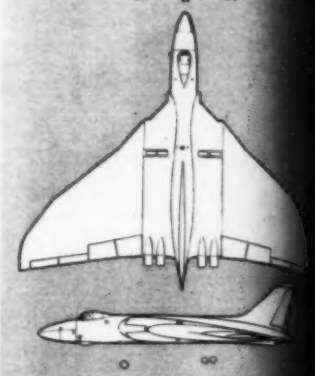
The first 748 is due to fly in February of next year, and target-date for certification and delivery is in the second half of 1961. Powerplant is the Dart 514 RDa.6, of 1,600 s.h.p., compared with the higher-powered (RDa.7) Darts of its two competitors. The RDa.6 has an approved overhaul life in excess of 2,000 hr. Airfield performance of the 748 is claimed to be "exceptional"; take-off field length (one engine out) is about 3,500ft in standard conditions, and landing distance from 50ft 2,310ft. The aircraft is intended to be able to use semi-prepared strips.

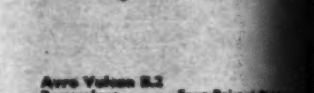
Shortly before announcement of the Indian Government's order (which might lead to an order from Indian Airlines Corporation as well as from the Indian Air Force), the Minister of Supply stated that his Ministry intended to purchase three 748s, at a total cost of about £750,000, for early operation and proving in service by a U.K. airline.

Shackleton MR.3 The Shackleton MR.3 (four R-R. Griffon) is in wide service with R.A.F. Coastal Command and the South African Air Force. It carries search radar, bombs, homing torpedoes, depth charges and sonobuoys as well as rescue containers and markers; like all Shackletons it is also cleared to transport over a score of troops.

Vulcan B.1 Several Squadrons in No. 1 Group, Bomber Command, are equipped with Vulcan B.1s. Each is powered by four Bristol Siddeley Olympus turbojets, the Mk 104 engines of recent B.1s being rated at 13,000 lb thrust dry. The large weapon bay can accommodate conventional or nuclear bombs, either of which can be delivered in a variety of ways with the assistance of a radar-controlled blind-bombing system. A Doppler radar, computer, astro sextants and other aids are carried for navigation; and probe and drogue flight refuelling is a standard fitting to extend the striking range of the aircraft. H.F./R.T. radio affords direct voice communication with ground stations almost anywhere in the world, and these can in turn be directly connected to a normal ground telephone system. All flying controls are fully powered by electro-hydraulic units, one operating each half of the split elevator and aileron surfaces to ensure continuity in case of a failure. A detailed description and cut-away drawing of the Vulcan, together with a history of its development, appeared in *Flight* for January 31, last year; and an account by a staff representative who flew in a Vulcan of No. 101 Sqn. during a bombing exercise appeared in *Flight* for July 18, 1958.

Vulcan B.2 Now entering squadron service, this developed version of the Vulcan has an extensively modified wing fitted with dual-purpose control surfaces, which removes aerodynamic buffet limitations and enables the aircraft to take advantage of much more powerful engines. The latter are of the Olympus 200-series, which have been type-tested at a dry thrust of 17,000 lb. All-round performance, and particularly range and over-target height, are considerably increased; and the B.2 is designed to deliver the Avro Blue Steel stand-off bomb. It is probable that Vulcan B.1s will also be modified to deliver Blue Steel at a later date.



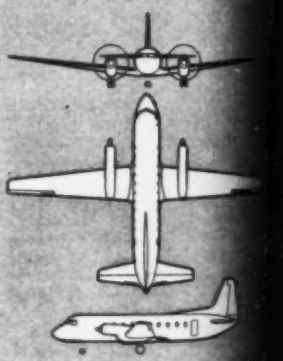


Avro Vulcan B.2

Powerplant	Four Bristol [illegible] Olympus [illegible]
Span	[illegible]
Length	[illegible]

Avro 748

Powerplant	Two Rolls-Royce [illegible]
Span	[illegible]
Length	[illegible]
Gross weight	[illegible]
Typical cruising speed	[illegible]



Avro 748

Avro Shackleton MR.3

AVRO VULCAN

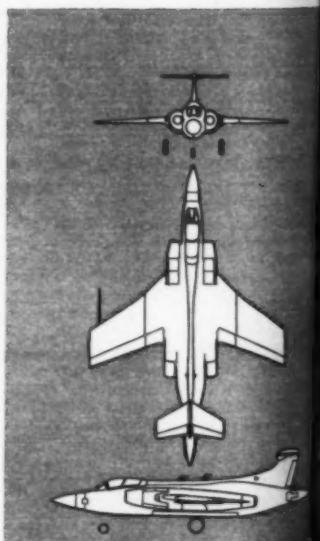
Blackburn NA.39

BLACKBURN AIRCRAFT LTD.

Brough, Yorks. Telephone: Brough 121

NA.39 No fewer than seven NA.39s have flown during the past 15 months out of the batch of 20 pre-production aircraft ordered four years ago; and each has flown precisely in accordance with the original schedule. Orders have now been placed to enable quantity production for the Admiralty to begin, and efforts have also been made to sell shore-based NA.39s to NATO air forces. Designed to survive sustained operation at low level and high speeds, the NA.39 is now being rapidly developed for its primary rôle as a low-level strike aircraft capable of operating from standard British aircraft carriers. At any operating altitude it can maintain near-sonic speeds and deliver weapons accurately in all weathers over a radius of action of about 500 miles. It is powered by two de Havilland Gyron Junior turbojets mounted beside the fuselage and arranged to provide bleed air for extensive supercirculation over both the wings and the slab tailplane; a Gyron Junior DGJ.1 equipped with two large bleed nozzles was exhibited at the S.B.A.C. display in 1957 and the thrust of this engine has been officially revealed as 7,000 lb dry. An NA.39 seen at the Paris Salon last June was provided with full-span blowing slots immediately aft of the leading-edge, ahead of the flaps and large ailerons and also beneath the tailplane, near the leading edge. An elevator-like trimming surface is unlocked at low speeds and the ailerons droop. To overcome the considerable residual thrust when high engine r.p.m. are needed to provide supercirculation on the approach, the 8ft-long tail-cone splits open to form extensive airbrakes of extreme effectiveness. With these special features the NA.39's wing attains the highest lift coefficient yet obtained from a fixed-geometry surface. Landing and take-off performance is superior to that of any comparable aircraft. To withstand the severe aeroelastic problems occasioned by operation at low level the NA.39 structure is particularly strong and fatigue-resistant and makes extensive use of integrally machined components. To reduce drag at high speeds the whole airframe is markedly area-ruled, with the result that the fuselage is sharply bulged aft of the wing. The long internal weapon bay in the belly is probably large enough to accommodate a wide range of nuclear weapons, and further space might house electronic equipment associated with air-to-air or air-to-surface guided missiles which might be carried for either offensive or defensive purposes. No guns are fitted.

The crew of two sit in tandem beneath a sliding canopy and have a comprehensive assortment of navigation aids, as well as bombing and mapping radar. It is obviously important that, while flying at high speed low down, the position of the aircraft and obstacles in its path should be precisely known. Doppler radar would probably be used for the former and bombing radar for the latter purpose. An automatic map plotter, with means for providing warning or control signals at specific points, has been developed by Kelvin Hughes. The NA.39 could approach its target at a variety of levels, although the final run-up would doubtless be made beneath the enemy radar and missile cover. A LABS system would probably be used for the delivery of a nuclear weapon.

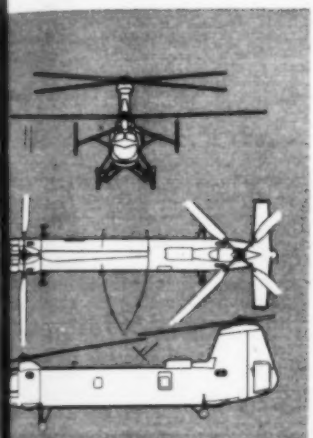


Blackburn NA.39
Powerplant: Two de Havilland Gyron Jnrs
Span ... ... ft
Length ... ... ft

Bristol 192

BRISTOL AIRCRAFT LTD.

Filton House, Filton, Bristol. Telephone: Filton 3831



Britannia 320 This is the current production version of the standard commercial 310, powered by more powerful Proteus engines (as retrospectively installed in 310s) and incorporating all design features necessary for compliance with U.K. and U.S. airworthiness requirements. Three 320s are being manufactured by Bristol for the shelf, all orders to date having been placed for the earlier 100/300/310 series. A total of 52 commercial Britannias of all series are in service, as follows: *B.O.A.C.*, 15 series 102 medium-range model and 17 series 312; Aeronaves de Mexico, two 302; Air Charter, two 305; El Al, four 313; C.P.A.L., six 314; Cubana, four 318; British and Commonwealth (Hunting-Clan), two 317. Certain Britannia 102s of B.O.A.C. are operated for, and in the markings of, Ghana Airways and Nigerian Airways. All told, therefore, Britannias are in operation with nine world airlines.

Britannia 250-series Built to military requirements, the 250 version is in service with R.A.F. Transport Command as the 252 (three) and the 253 (delivery mainly by Short Bros.; 20 on order). Both incorporate a big forward freight door. The 252 has its forward floor strengthened for heavy freighting, the main body of the fuselage being designed principally for trooping. The 253 is essentially a freighter, with a heavy-duty floor throughout.

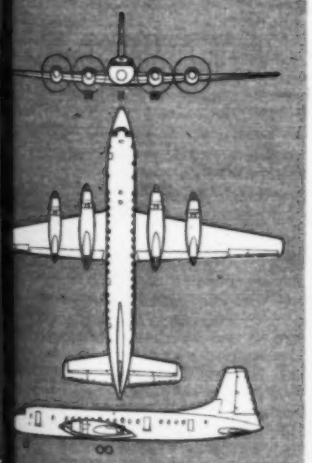
Type 188 One of the few entirely new high-performance aeroplanes now awaited from a British factory, the Type 188 is officially described as "a stainless-steel supersonic research aeroplane," and another reference to it speaks of the use of ceramics in its construction. These vague hints at extreme kinetic heating suggest ability to hold sustained Mach numbers greater than three, and this it must assuredly do if it is to break any ground not yet well trodden by America. No details of the aircraft may be divulged beyond the fact that the engine chosen is the de Havilland Gyron Junior DGJ.10 (10,000 lb dry, 14,000 lb with afterburner). The first Type 188 may be expected to fly during the coming winter.

Bristol 205 Not officially announced, the 205 is a project aimed at fulfilling the specialist requirements of the short-range jet airliner market. Seating for 60-70 passengers, and two or four rear-mounted Bristol Siddeley engines, are reported to have been considered.

Type 192 Eight of these multi-purpose, twin-engined helicopters are now flying and the first R.A.F. transport squadron should be formed next summer. Powered by two Napier Gazelle free-turbine engines, the Type 192 has a gross weight of 18,000 lb and a cruising speed of 120 kt. Each Gazelle normally delivers 920 s.h.p., but 1,650 s.h.p. are available for emergencies, so that a fully loaded 192 can hover and climb on one engine. The two Gazelles are mounted at either end of the 24ft-long cabin, and a synchronizing shaft along the top of the fuselage allows one engine to drive both rotors.

Multiple rôles include the transport of 18 fully armed troops (for 210 n.m.), eight or 12 stretcher cases, an internal load of 6,000 lb or up to 5,250 lb suspended beneath the fuselage or 14 rescued persons. Long-range tanks allow a ferrying range of 620 n.m. Fittings are provided for stretchers, a scrambling net at the main door, electrically-heated blankets, and for towing surface craft; and in a strengthened door is mounted a 600 lb winch.

Type 192C This 24-passenger civil version of the 192 should become available early in 1961. Engineering changes are being minimized, although 13 windows will be provided in the main cabin. Breaking even on total costs at 65 per cent load on a London - Paris sector, the return fare would be £22 14s. Cruising speed would be 140 m.p.h.



Bristol Britannia C.1 (Model 253)

de Havilland Sea Vixen FAW.1

THE DE HAVILLAND AIRCRAFT CO. LTD.

Hatfield, Herts. Telephone: Hatfield 2345

Airco D.H.121 First details of B.E.A.'s new jet airliner, for which a contract for 24 was signed on August 12, have been published, and appear elsewhere in this issue. To be built by the Airco consortium comprising de Havilland, Fairey and Hunting, the 121 is in the Viscount-replacement class, and is intended for operation on the world's short-haul routes (200-1,200 st. m.). It has a three-engined layout, with three Rolls-Royce RB.163s (10,100 lb thrust each) mounted at the rear for maximum aerodynamic efficiency and cabin quietness. The three-engined configuration is claimed to provide the best balance between the thrust-requirements of take-off and cruise, and to give the best economics.

Seating for 79 (mixed class) or up to 97 (economy-class six-abreast) is provided. Best-economy cruising speed at 32,000ft is 585 m.p.h.; max. cruising speed at 25,000ft is 606 m.p.h. A notable feature of value in frequent-stop services is the high "residual range" provided by the high proportion of landing weight (100,000 lb) to max. weight (105,000 lb).

D.H. 123 Although de Havilland Aircraft have so far refrained from describing this project they do acknowledge its existence. Last April this journal suggested that it may be a DC-3 replacement, with characteristics differing markedly from the F.27, Herald and Avro 748 formula; powered by a pair of de Havilland P.1000 turboprop Gnomes, each rated at 1,000 s.h.p., it is likely to be a high-wing aeroplane, seating 40 passengers and matched to short-haul operations.

Comet 4 Series Three basic variants of the de Havilland jet transport family are offered: Comet 4, 4B, 4C. Common to all versions is the Rolls-Royce RA.29 turbojet engine.

The production programme calls for a total of 19 Comet 4s to be delivered to B.O.A.C. by the end of 1959; as the Farnborough display opens, the Corporation had received 15 of its fleet. Another Comet 4 operator, Aerolineas Argentinas, has three of its order for six in operation between Buenos Aires and New York and B.A. and Europe. A third Comet 4 customer, East African Airways Corporation, has three aircraft on order for delivery in June and July, 1960.

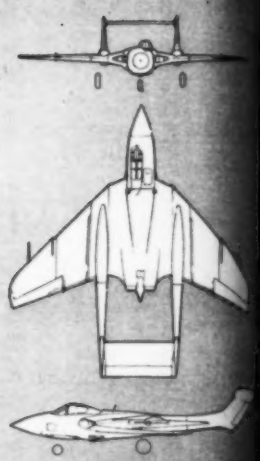
Comet 4Bs have been ordered by British European Airways (7, for delivery from January 1960) and Olympic Airways (two, early 1960). The 4B is the "continental" variant of the medium/long-range Comet 4, with seating capacity increased from 80 to 102 by a 6½ft stretch of the fuselage, and reduced fuel tankage (no pod-tanks). To permit higher cruising speeds at low altitude, the span is reduced by about 7ft.

The Comet 4C combines the wing (and hence tankage) of the basic series 4 with the increased fuselage capacity of the 4B. It is known as the intermediate-range Comet; no firm orders have as yet been announced.

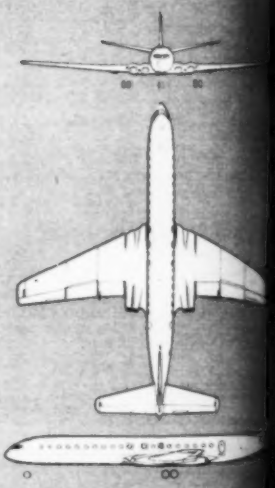
Comets are in production at Hatfield and Chester. Increased power-potential of the RA.29 Avon suggests the possibility of continued improvements in payload-range capabilities.

Sea Vixen Fleet Air Arm squadrons of Sea Vixen all-weather fighters are to be operational in the near future and production is under way at Christchurch. Powered by two Rolls-Royce Avon 200-series engines, the Sea Vixen carries a crew of two, an advanced fire control radar and a fixed armament of two retractable, 14-tube rocket containers produced by Microcell. Three pylons under each wing can accommodate tanks, bombs, rockets, or Microcell honeycomb rocket packs. Standard intercepter armament is four de Havilland Firestreak infra-red-homing missiles. The Sea Vixen can probably carry a nuclear store, and a flight refuelling probe is fitted in the port wing. To provide good control from supersonic down to carrier-approach speeds the response of the tailplane is doubled at transonic speeds and the lowering of the flaps automatically unlocks an elevator surface which acts as a trim and geared tab. The datum of the control column is also shifted forward at lower speeds. The autopilot operates the ailerons as elevons. Spring feel is applied to tailplane and ailerons, and q-feel to the rudders. The wings and radar nose fold for carrier stowage and the aircraft is rotated to a fully tail-down attitude for catapulting.

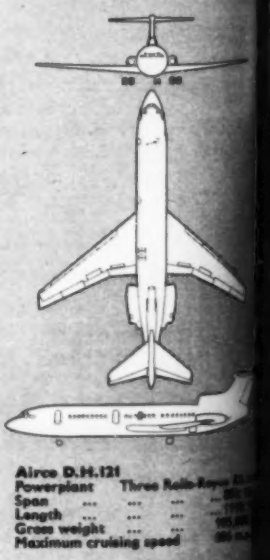
Airco D.H. 121



de Havilland Sea Vixen FAW.1
Powerplant Two Rolls-Royce Avon
Span
Length



de Havilland Comet 4B
Powerplant Four Rolls-Royce
Span
Length
Gross weight
Typical cruising speed



Airco D.H.121
Powerplant Three Rolls-Royce
Span
Length
Gross weight
Maximum cruising speed

B·O·A·C
Comet 4

English Electric Lightning F.1

THE ENGLISH ELECTRIC CO. LTD.

Marconi House, Strand, London, W.C.2. Telephone: Covent Garden 1234

Canberra B(I).8 The night interdicter version of the Canberra has now been in R.A.F. service for some years, together with the B.2 bomber, T.4 trainer, B.6 and B(I).6 bomber and interdicter and the T.11 four-seat A.I. trainer. Some 500 Canberras have been built under licence in Australia and America and more than 800 of all types have been built in Britain by English Electric, Short, Avro and Handley Page. The T.11 was converted from the B.2 by Boulton Paul, who also designed the 4×20 mm gun pack for the B(I).8. This version carries Doppler radar and LABS bombing equipment and pylons for a 1,000 lb bomb under each wing. Bomber Canberras accommodate a pilot and two navigators side-by-side behind, while the B(I).8 has a bubble canopy offset to port for the pilot and a seat in the nose for a navigator/bomb-aimer. A description and cut-away drawing appeared in *Flight* for March 14, 1958.

Used for photographic reconnaissance, the PR.3 and PR.7 Canberras are respectively equivalent to the B.2 and B.6 and have increased fuel tankage and groups of cameras. PR.9 and U.10 versions are made by Short. Several B.2s have been fitted with Napier Double Scorpion rocket motors.

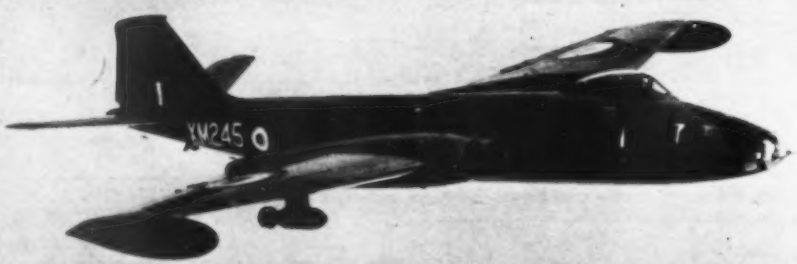
Lightning Full production of this highly supersonic, all-weather intercepter for the R.A.F. is now under way. The pre-production batch of 20—preceded by three prototypes and two P.1As—has been virtually completed, and the first operational squadron should be formed at the beginning of next year. The Lightning is powered by a pair of late-model afterburning Rolls-Royce Avons, mounted one above the other in the fuselage, the lower engine being somewhat ahead of the upper. The circular nose intake admits air round a centre bullet which accommodates the Ferranti Airpass fire-control radar which, together with an autopilot, ensure that all types of interception can be made automatically, leaving the pilot to supervise the overall operation. It was announced early this year that, during routine testing, the Lightning has reached M 2 in level flight and maintained this speed with minimum reheat. Specific performance figures are not released but the machine has a very high rate of climb and ceiling. The latter can be further increased by the addition of a Napier Double Scorpion rocket pack in place of the ventral tank of standard R.A.F. versions. Exceptionally powerful armament can include two de Havilland Firestreaks attached by pylons to a pack installation beneath the forward fuselage and two Aden 30 mm guns flanking the cockpit. The missile pack can be replaced by a twin-Aden gun pack or two batteries of unguided rockets stowed internally. In addition to the autopilot the Lightning has the latest roller-blind flight instrument system. It is in fact equipped for night and day all-weather operation, and has often demonstrated its ability to land with a ground-run of about 1,000 yd. There is still considerable development potential and it has been stated that the aircraft is capable of accommodating the larger and more powerful missiles now being developed.

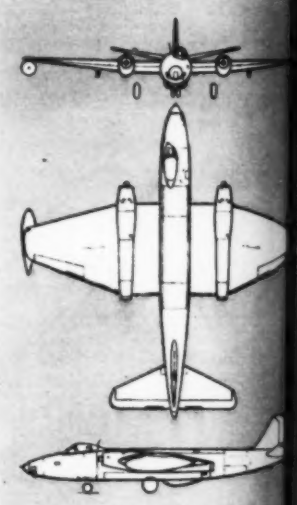
An exclusive cut-away drawing in *Flight* of January 10, 1958, clearly showed the structure of the 60 deg swept wing with its five spars and integral tankage disposed all round the main undercarriage bays. Ailerons are mounted transversely across the wing-tips, and the slab tailplane, with a plan-form similar to that of the wing, is actuated by twin Hobson screwjacks mounted beneath the lower jetpipe. The distinctive undercarriage was designed by British Messier and has a steerable nosewheel. Air brakes are mounted high in the fuselage flanks, ahead of the fin, and a ribbon drag-chute is standard.

Lightning Trainer The first two-seat version of the Lightning took the air, a fortnight ahead of schedule, on May 6 and exceeded M 1 within 15 minutes. The type is now in full production in parallel with the Lightning intercepter. The principal modification is the provision of a side-by-side two-seat cockpit with two Martin-Baker ejection seats beneath a single-piece, clam-shell canopy. Also known as the P.11, the Trainer could fly an operational sortie.

TSR.2 This advanced R.A.F. machine is described on page 135.

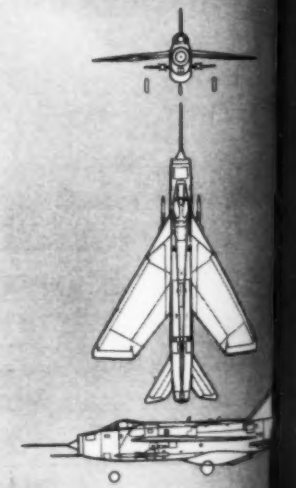
English Electric Canberra B(I).8





English Electric Canberra B(I).8
Powerplant Two Rolls-Royce Avon
Span ... ...
Length ... ...
Gross weight ... ...
Maximum speed ... ...

English Electric Lightning F.1
Powerplant Two Rolls-Royce
Span ... ...
Length ... ...
Maximum speed ... ...



P.11 Lightning Trainer

Fairey Gannet AEW.3

FAIREY AVIATION LTD.

Hayes, Middlesex. Telephone: Hayes 3800

Gannet AS.4 and T.5 In both AS.1 and AS.4 versions, the latter with a more powerful Bristol Siddeley Double Mamba turboprop, the Gannet is the standard Fleet Air Arm anti-submarine aeroplane, accommodating a crew of three in separate cockpits. Search radar is carried in a retractable radome and a large weapon-bay can accommodate two homing torpedoes or bombs, mines, depth charges, sonobuoys and other stores. Rockets and other weapons can be carried on under-wing racks.

The T.2 and T.5 are trainer versions of the early and late AS machines. They are fitted with dual control in the two front cockpits and carry no radar. Gannets have been exported to the navies of Australia, Western Germany and Indonesia.

Gannet AEW.3 The only type of Gannet remaining in production, the AEW.3 is a completely redesigned machine for fulfilling the carrier-based airborne early warning rôle. In service with the Royal Navy it will replace the Douglas AD-4W Skyraider.

In order to accommodate the monstrous radar scanner and its radome the legs of the undercarriage have been lengthened, and accommodating them when retracted has called for corresponding modification to the wing. The latter is completely de-iced by Napier Spraymat elements, which are also fitted to the leading edges of the triple-fin tail and to the intake of the Bristol Siddeley Mamba, the latter being of the most powerful version of this engine. As is now well known, the Double Mamba is so designed that in cruising flight one half of the engine, and one of the two co-axial propellers, may be shut down. The pilot of the AEW.3 sits alone above the nose and two radar observers occupy the rear cabin. Carrier trials have shown that the type will be well received when it enters service shortly.

Rotodyne Unique in its class, and hovering half-way between fixed-wing airliner and helicopter airliner in its definition, the Rotodyne is a twin-turboprop VTOL transport designed primarily for economic city-centre to city-centre operations. It combines a forward cruising speed (over 200 m.p.h.) higher than a Dakota with the VTOL and hovering capabilities of a helicopter, and it has a seating capacity for a maximum of 65 passengers (five abreast). Basic price is being quoted at about £500,000.

Powerplant of the production aircraft, the first of which is expected to fly in the autumn of 1961, is an adaptation of the 5,000 h.p.-plus Rolls-Royce Tyne turboprop which powers the Vickers Vanguard and Canadair CL-44 transports. The prototype Rotodyne, which has been on test since November 1957, is fitted with Napier Eland turboprops of about 2,800 h.p. each driving D.H. propellers (which will also be fitted to the production Rotodyne's Tynes).

Basic principle of the Rotodyne is as follows: the powerplant feeds fresh compressed air to the main rotor for vertical flight, most of the engines' power being absorbed by the big (104ft) single lifting rotor. Additional power is obtained from rotor-tip kerosine-burning pressure jets. After take-off transition to forward flight is accomplished by progressively transferring power from the rotor to the conventional propellers, upon whose free-air thrust the aircraft then solely depends for cruising. A conventional wing contributes about 60 per cent of the lift in the cruising condition, the remainder being provided by the auto-rotating rotor.

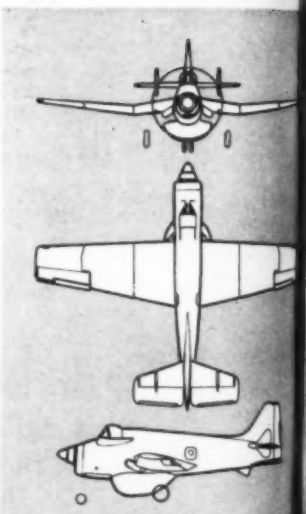
A number of provisional orders for Rotodynes have been announced, even though it will not be until 1963-64 that deliveries will be made.

B.E.A. intend to purchase six, and have an option on a further 14, and their plans envisage the use of Rotodynes on cross-Channel as well as United Kingdom domestic city-centre to city-centre services.

In accordance with U.K. Government policy of unifying the transport needs of civil and military operators, negotiations between the Ministry of Supply and Fairey anticipate the placing of an order for a military version. The Rotodyne recently carried out a series of "flying crane" aerial bridge-laying demonstrations for Service representatives; a section 103ft × 7ft × 10ft was transported three miles (picture opposite).

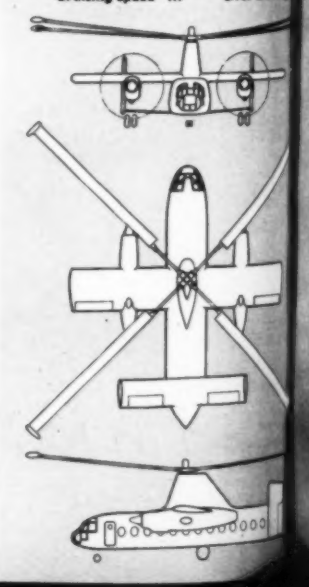
An order from New York Airways, who are the world's most experienced operators of commercial helicopter operations, was announced in March 1959. N.Y.A. intend to purchase five, with an option on a further fifteen, delivery of the five to be completed by the spring of 1964. Closely concerned in the negotiations with New York Airways in the negotiations for Rotodynes were Kaman Aircraft Corporation of Bloomfield, Connecticut, who are sales and servicing agents for the Rotodyne and who hold the manufacturing licence for the aircraft (though not the engines) in the United States.

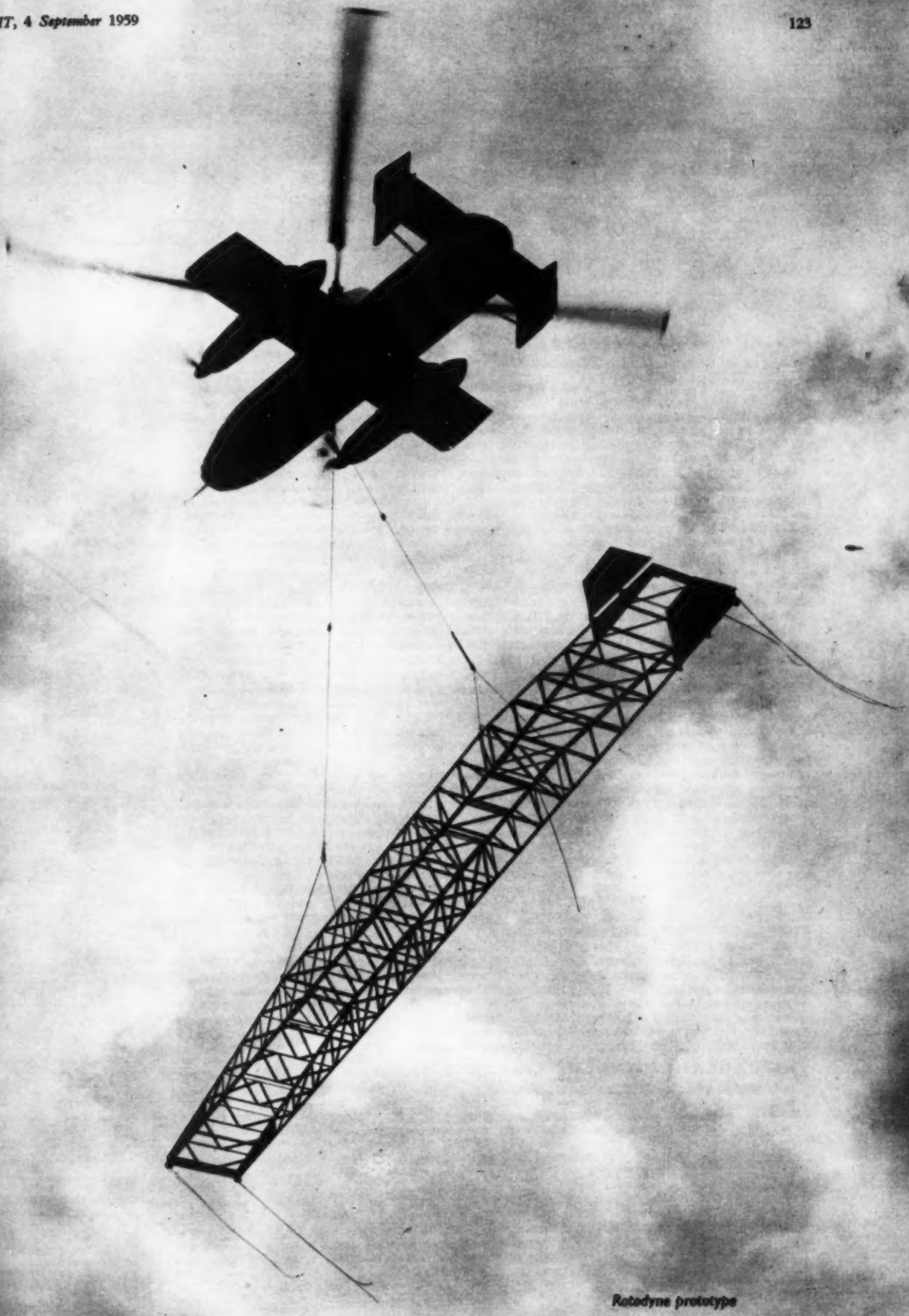
Okanagan Helicopters Ltd., one of the world's largest helicopter operators (54 helicopters) who operate from Vancouver Airport, were the first to order the Rotodyne, having indicated their intent to purchase one plus a possible further two (on option) for scheduled services to Victoria and Seattle.



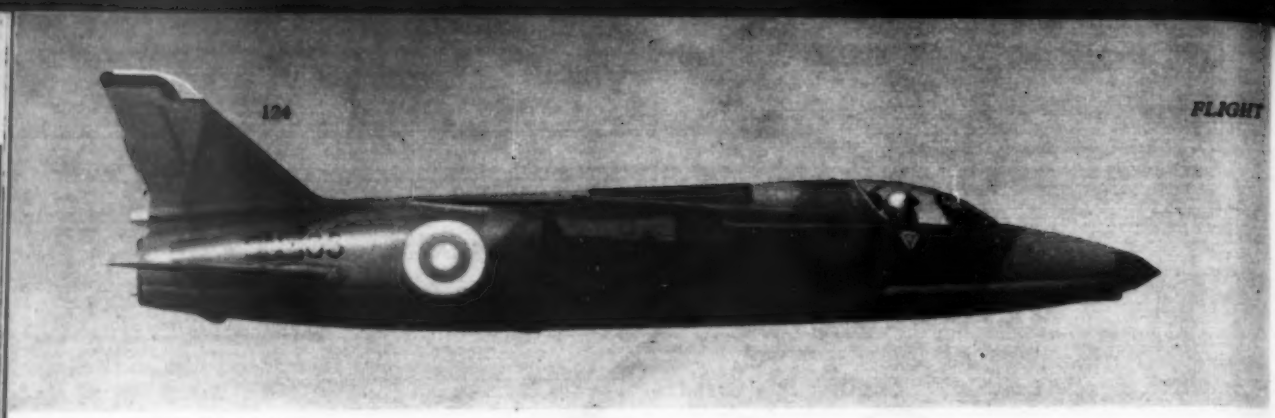
Fairey Gannet AEW.3
Powerplant Bristol Siddeley Double
Span ... ...
Length (without sting) ... ...

Fairey Rotodyne (production
Powerplant Two Rolls-Royce
Span ... ...
Rotor diameter ... ...
Fuselage length ... ...
Gross weight ... ...
Cruising speed ... Over





Rotodyne prototype



Folland Gnat Mk 1

FOLLAND AIRCRAFT LTD.

Sydney Lodge, Hamble, Hants. Telephone: Hamble 3191

Gnat Mk 1 Following the clearance for service with both the Indian and Finnish air forces, production Gnat Mk 1s are now being delivered to these countries, and two have been supplied for evaluation in Jugoslavia. In addition, components and tooling are being shipped to India preparatory to production under licence by Hindustan Aircraft. Weighing 6,250 lb in the intercepter configuration, the Gnat is powered by a Bristol Siddeley Orpheus 701 turbojet of 4,700 lb thrust, which affords spectacular acceleration and climb, and M 1 can be exceeded in a shallow dive. The fully powered slab tail carries an elevator surface which may be unlocked for reversion to manual control in emergency. The inboard ailerons automatically droop when the undercarriage is lowered, and partial extension of the latter allows the fairing doors to act as airbrakes. Standard armament consists of two 30 mm Aden guns, with a radar-ranging sight, and a full range of under-wing stores or tanks carried on two pylons. With stores, the gross weight varies between 7,550 lb and 8,600 lb. In the intercepter rôle, take-off distance to 50ft is 2,620ft, and landing distance from 50ft is 3,500ft. Endurance with under-wing tanks is 2.5 hr and maximum level speed, M 0.98. Climb to 45,000ft takes 5.25 min, and the ceiling is over 50,000ft. The wing has a t/c ratio of 8 per cent and an area of 136.6 sq ft.

Gnat Mk 2 A 6 per cent wing for a supersonic M 1.5 version of the Gnat fighter has already been built and could be fitted to a Mk 1 fuselage. A reheated version of a later mark of Bristol Siddeley Orpheus, combined with the new wing, would provide a marked increase in rate of climb and level speed with relatively little alteration to the basic aircraft. It is, however, probable that the supersonic fighter would have more advanced radar equipment and be capable of all-weather operation.

Gnat Trainer Mk 1 Developed from the transonic Mk 1 fighter, the Trainer accommodates pupil and instructor in tandem in Folland Type 4 fully automatic ejection seats under a single-piece, clamshell canopy. A development batch of 14 has been ordered for the R.A.F. as the T.1. The instructor occupies space previously used for equipment and fuel, and the latter have been moved respectively into the nose and the former gun compartments. The fuselage is also lengthened by 9in. The new wing, of 175 sq ft area and 7 per cent t/c ratio, houses 100 gal of fuel in integral tankage round the multiple spars. Outboard ailerons and inboard flaps are fitted, thus providing low-speed handling suitable for a trainer without compromising high-speed performance. All tail surfaces are of increased area and the powerplant is a Bristol Siddeley Orpheus 100 giving 4,230 lb thrust. The airframe is designed for a ten-year life of 5,000 hr flying.

The first Trainer should fly at the S.B.A.C. display. The latest roller-blind instrumentation is being fitted. A power-operated slab tailplane, with an elevator which can be unlocked for manual flying, is being retained; the rudder is mechanically operated against feel springs and reversion of the powered ailerons to manual control is automatic. Internal tankage of 260 Imp. gal will allow an endurance of almost two hours, which can be increased to some three hours with two 66-gal under-wing tanks. The Gnat T.1 will exceed M 1 in a dive and reach M 0.97 in level flight. It will climb to 40,000ft in 10 min, will be cleared for spinning with drop-tanks in place and will be able to operate from 6,000ft runways in any weather.

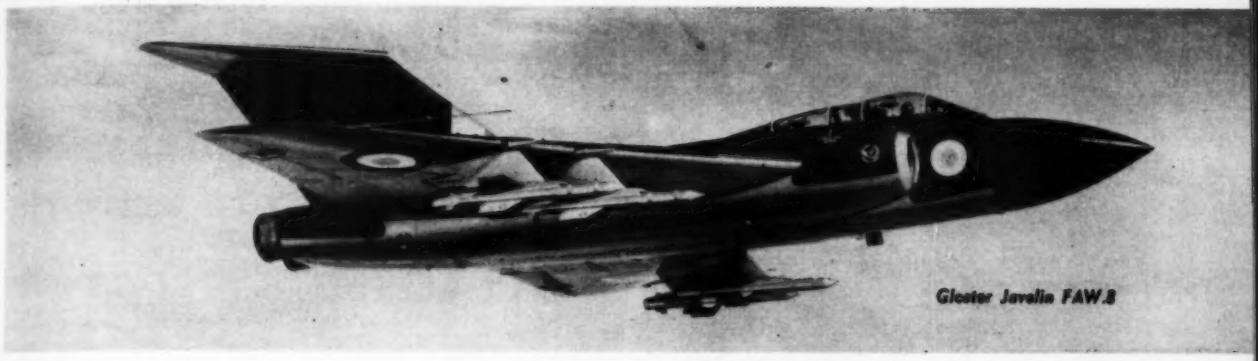
Gnat Trainer Mk 2 This is a supersonic project based on the same forward and centre fuselage as the Mk 1, but having a wing of 150-160 sq ft and 5 per cent t/c ratio, fitted with high-lift trailing- and full-span leading-edge flaps and advanced lateral-control devices. These features would permit supersonic level flight while maintaining stalling and low-speed characteristics suited to training and carrier-borne operations. The Orpheus engine would have a Bristol Siddeley reheat system requiring a tailpipe diameter increased by 50 per cent to 30in. Integral tankage would allow almost the same endurance as that of the Mk 1 Trainer, but a speed of M 1.5 and a time to 50,000ft of 3.5 min from brakes off would be possible.

THE GARLAND-BIANCHI AIRCRAFT CO.

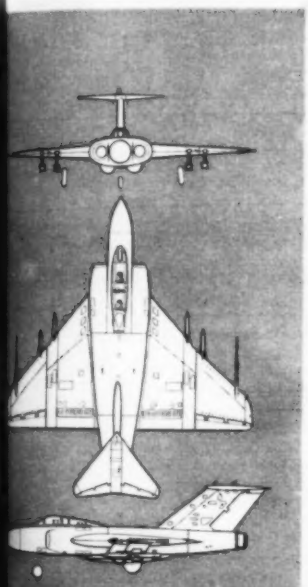
Boyne Hill Works, Maidenhead, Berks. Telephone: Maidenhead 906

Linnet Production of this licence-built version of the Piel Emeraude is now beginning in the Maidenhead factory following construction and testing of the first English-built machine during the past year. The test pilot during this time has been Neville Duke. The French designer of the original ultra-light Emeraude is known to have been an admirer of J. R. Mitchell, who designed the Spitfire, and the two aircraft bear some resemblance in wing plan-form. The Linnet is a side-by-side two-seater with a fixed spatted undercarriage and a Continental 90 h.p. engine. Structure is of wood with fabric covering. Mechanically operated, slotted plain flaps are mounted inboard of the slotted ailerons. The cabin is roomy and comfortable and affords ample space for baggage behind the seats. A total fuel capacity of 28 gal, allowing more than 5.5 hr endurance, is divided between two tanks, fore and aft of the seats. The tailwheel is steerable and both cabin and carburetter heating are provided from exhaust manifold muffs. Full blind-flying instruments can be provided. Gross weight is 1,400 lb and cruising speed just over 120 m.p.h. Electric starter and generator are standard, and radio can readily be fitted. The cost of the Linnet is little over £2,000.

Garland-Bianchi Linnet

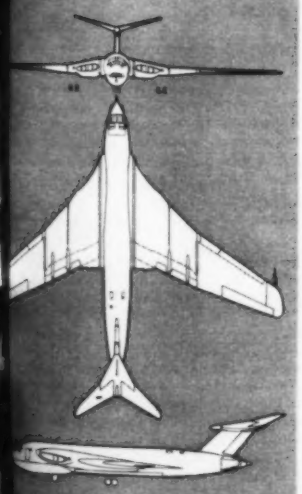


Gloster Javelin FAW.8



Gloster Javelin FAW.9
Two Bristol Siddeley Sapphire ASSa.7R
52ft
56ft 4in

Handley Page Victor B.2
Four Rolls-Royce Conway RCo.11
120ft
114ft 11in



GLOSTER AIRCRAFT CO. LTD.

Gloucester, Glos. Telephone: Gloucester 67011

Javelin A number of marks of this all-weather fighter have now been in R.A.F. service for several years and the latest variant to be released is the FAW.9. The Mk 9 is similar to its predecessors, but incorporates minor aerodynamic and electronic modifications and rationalizes other improvements effected in the FAW.7 and 8. The former was the first to be fitted with de Havilland Firestreak air-to-air missiles, four of which are carried on underwing pylons, as well as two Aden 30 mm guns in the wings. It was also the first to be fitted with the more powerful Bristol Siddeley Sapphire 200 series engines; the FAW.8 is distinguished by having reheat. These three versions have a battle camera in the starboard wing outboard of the pylons, stall-warning sensers on the upper skin of each wing and dynamic-pressure intakes above the rear fuselage serving the feel system for the fully-powered, all-flying tail. As well as accommodating Firestreaks, the pylons can carry Microcell 37-tube honeycomb launchers for 2in spin-stabilized rockets. All marks of Javelin can carry two ventral tanks, side by side, each holding 250 Imp. gal. The later marks of Javelin have excellent high-subsonic performance and even the earlier versions were in this respect comparable to the Hunter. Pilot and observer are accommodated in tandem under linked sliding canopies and sit in Martin-Baker automatic ejection seats. Any of a number of types of powerful A.I. search radar is installed in the nose. Fully powered ailerons are mounted outboard on the kinked-delta wing and split flaps are fitted inboard, ahead of the trailing-edge. Slotted airbrakes extend above and below the wing.

Javelin FAW.1s, armed with four 30 mm Aden guns and not capable of carrying missiles, first went into R.A.F. service in limited numbers in 1956. They were immediately followed by the FAW.2, the main innovation of which was the all-flying tail. New features of the FAW.4 were a feel system for the all-flying tail, radar altimeter, new interception radar and a revised tail fairing. In the meantime, Air Service Training Ltd. modified an FAW.4 to a pilot trainer designated T.3. This had a revised cockpit, increased internal fuel capacity, simplified radar, cockpit periscopes and a fuselage lengthened by 4ft. Vortex generators ahead of the ailerons, and blunt trailing-edges for the latter, were also incorporated. The FAW.5 was based on the FAW.1 but had more fuel and the all-flying tail. The FAW.6 was a similar modification of the FAW.2.

HANDLEY PAGE LTD.

Claremont Road, Cricklewood, London N.W.2. Telephone: Gladstone 8000

Victor B.1 We recorded a year ago that the first squadron of the Victor B.1 "crescent wing" jet bombers (four Bristol Siddeley Sapphire turbojets) had been formed in No. 3 Group, Bomber Command. Other formations have since been equipped, including a photographic-reconnaissance unit.

A crew of five is accommodated in the characteristically shaped nose section, which carries a large bombing and navigation radar in its lower part. Excellent handling characteristics result from the use of high-lift flaps and drooping leading edges, in conjunction with a high set tailplane. The eight-wheel bogies of the main undercarriage unit retract rearwards to lie within the wing and there are large airbrake surfaces at the rear end of the fuselage.

It is the makers' proud claim that during 1957 a Victor of this mark exceeded the speed of sound by a margin of about 15 m.p.h. and at a height of about 40,000ft.

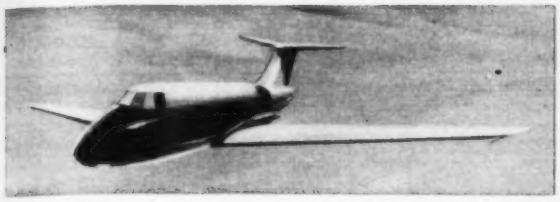
In order to reduce to a minimum the number of complicated final-assembly jigs, relatively simple sub-assembly jigs have been extensively used. This structural break-down has readily lent itself to the manufacture of corrugated sandwich-skin panels, consisting of a corrugated core of aluminium alloy sheet attached to an inner skin by blind rivets and to an outer skin by spot welds. The result is a light structure of excellent stiffness and strength, wherein bending loads are carried by the skin. Conventional stiffening components have been considerably reduced in number. Corrugated panels enable fuel tanks to be pressurized without weight penalty and allow much space which would otherwise have been devoted to structure to be made available for these tanks and other equipment.

Production of the first two marks of Victor has attained peak rates and the following facts were released earlier this year: The Victor needs 15,000 drawings and has 40,000 detail parts; its electrical system is connected by over 40 miles of cable; it has 2,200 items of equipment supplied by the Government or outside manufacturers; more than 100 sub-contractors are involved.

Victor B.2 It has been stated by the Minister of Supply that this improved mark of Victor will remain one of the mainstays of Bomber Command for ten years. Four Rolls-Royce Conway RCo.11 turbojets, each of 17,250 lb thrust, are installed and there are some notable external differences including increased wing span, enlarged air intakes and retractable scoops just forward of the tail fin. When extended these scoops draw in ram air to drive turbo-alternaters for high-altitude emergency auxiliary power. Auxiliary power for use at low altitude is supplied by a Blackburn Artouste gas turbine in the starboard wing root. On the ground the Artouste is used for starting the Conways, thus rendering the Victor B.2 independent of outside assistance on remote airfields.

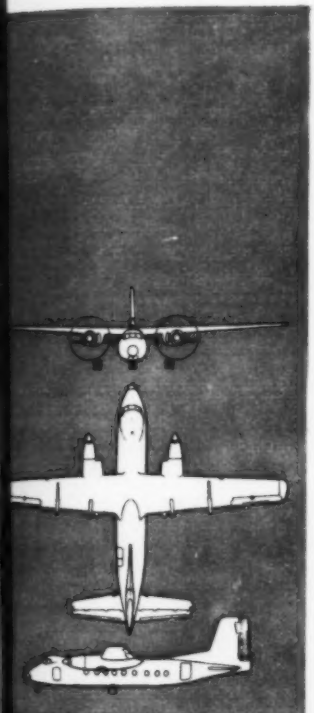
In a demonstration earlier this year a Victor B.2 was observed to take off after a run of only 410 yd, using 100 per cent thrust from two of its Conways and reduced thrust from the other two.

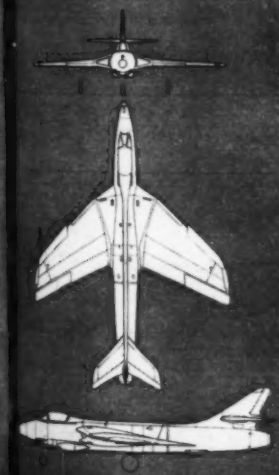
XA930
Vickers



H.P.113

H.P. Dart Herald





Dart Herald Now nearing the completion of its tests, with airworthiness certification due in March of next year, the 36-47 passenger Dart Herald ranks as the first British contender for the elusive but very large potential market for a Dakota replacement.

Conceived as a private venture in 1953, and flown in August 1955 with four piston engines, the Herald was subsequently developed into a turboprop transport by conversion to two Rolls-Royce Dart RDa.7/2 527s of 2,100 e.h.p. each. In this form it has since been intensively promoted as the branchline and feederline operator's answer to the problem of how to make money on these economically difficult routes. British European Airways will next year operate a fleet of three, on loan from the Ministry of Supply, on the Corporation's Scottish routes.

Last April the Dart Herald embarked upon an ambitious series of world demonstration tours. The aircraft first visited potential airline and air force customers in the Middle East and Asia, and during July and August carried out, on schedule, an extensive tour of a dozen South American capitals. After the S.B.A.C. Display tours of Africa, Australia and New Zealand will be undertaken.

H.P.113 With full-chord laminar flow, achieved by a boundary-layer control system, the H.P.113 project is a small executive jet transport for 8-12 passengers capable of carrying its maximum payload of 2,500 lb at 530 m.p.h. for a stage distance of more than 3,500 st. miles.

This spectacular range-payload performance is made possible by the reduction of drag achieved by boundary layer control.

Powerplant, mounted internally in the extreme rear of the fuselage, comprises two Bristol Siddeley Orpheus of 5,250 lb thrust. The wing and tailplane boundary layers are sucked away through machined 0.005in slits (and, locally, through sintered porous steel) by two four-stage axial compressors driven by the two Orpheus; for take-off these compressors, by acting as ducted fans (with their own retractable intake scoops) increase thrust by up to 50 per cent.

Salient estimated data are: span, 71ft 3in; length, 71ft 6in; fuel, 2,290 Imp. gal; max. weight, 36,500 lb; cruising height, 43-50,000ft; take-off distance (sea level, max. weight), 1,660ft.

HAWKER AIRCRAFT LTD.

Richmond Road, Kingston-on-Thames, Surrey. Telephone: Kingston 7741

Hunter More than a thousand Hunters of all marks up to and including the F.6 have been built, many to American "off-shore" orders. Following intensive competitive evaluation, particularly in Switzerland, the F.6 has been acknowledged as the best ground-attack fighter currently available. The type is in service with the British, Swedish, Danish, Dutch, Belgian, Peruvian, Indian, Iraqi and Swiss air forces. In Britain, Hunters have been built by both Hawker and Armstrong Whitworth and licence production was undertaken jointly in Holland and Belgium. The Hunter F.6 is powered by a Rolls-Royce Avon Mk 203 turbojet giving 10,000 lb thrust and has fully powered controls with manual reversion as a standby. The tailplane electrically follows up elevator movement to form an "all-flying" control which is fully effective and pleasant to use. Fixed armament consists of a removable pack of four Aden 30 mm guns and under-wing pylons can carry 100 gal or 230 gal tanks and a full range of rockets, bombs and napalm. Individual Hunters have been converted to carry Fairey Fireflash and de Havilland Firestreak missiles, and Bofors and Oerlikon unguided rockets can be fitted on the existing pylons. The cockpit is, of course, pressurized, and a Martin-Baker ejection seat is standard. In the clean, interceptor configuration the Hunter F.6 weighs 17,600 lb, carries 390 Imp. gal of fuel internally, can attain 621 kt at sea level, climb to 46,000ft in 6.75min, and has a ceiling of 53,400ft. Carrying an additional 660 Imp. gal of fuel externally the Hunter weighs 23,700 lb and can fly 1,610 n.m. With two 1,000 lb bombs and two 100-gal drop tanks it has a radius of action of 190 n.m. cruising at 1,000ft and 305 n.m. when cruising at 39,000ft. In both cases a 5-min ground-level period is allowed for the attack. Take-off run clean and at 23,700 lb are respectively 980 yd and 1,720 yd, and the landing distance over 50ft is 1,550 yd.

Hunter T.7 Based on the F.4 and powered by a Rolls-Royce Avon 100-series turbojet of some 8,000 lb thrust, this side-by-side two-seat trainer is in service with the R.A.F. and the Danish and Dutch air forces. It carries a single Aden gun in a blister under the starboard side of the nose and the normal complement of pylon-mounted stores, as well as a radar-ranging sight. A braking parachute is fitted in a fairing above the tail-pipe. A more powerful trainer, based on the F.6 with an Avon Mk 203, has been ordered as the Mk 66 by the Indian air force. The prototype of this version was flown by C. M. Lambert of *Flight's* staff (issue of May 17, 1957). It showed excellent performance and fine handling characteristics, and easily exceeded M 1 in a shallow dive, retaining full elevator effectiveness. The Hunter two-seater is capable of fulfilling an operational rôle.

Hunter T.8 In full service with the Fleet Air Arm, this is a slightly modified version of the T.7, the main innovation being an arrester hook intended for emergency use on runways. The single Aden gun, radar-ranging gunsight and braking parachute are retained.

Hunter FGA.9 Mention has recently been permitted of this specialized ground-attack version of the Hunter F.6.

Hunter FR.10 Most recent Hunter variant of which mention is permitted is this fighter/reconnaissance version of the F.6 carrying a battery of cameras in a modified nose.

P.1127 Under this project number Hawker Aircraft have for many months been engaged in the development of a VTOL strike/fighter of very advanced design. Powered by "a special Bristol Siddeley engine"—possibly the BE.53 turbofan—the P.1127 is intended as the third-generation tactical aircraft for NATO countries, and its development is accordingly being supported by MWDP funds.

Hunter Two-Seater

Hunting Jet Provost T.3

HUNTING AIRCRAFT LTD.

Luton Airport, Luton, Beds. Telephone: Luton 6060

Jet Provost T.3 First deliveries of this standard *ab initio* trainer have now been made to the R.A.F. and production is in full swing. A number of the earlier marks have already seen some years' service with Flying Training Command. Powered by a Bristol Siddeley Viper ASV.8 turbojet, the Jet Provost is the first jet trainer ever to be standardized by any air force for primary training. It is a low-wing monoplane with a retractable nosewheel undercarriage, and seats instructor and pupil side-by-side in Martin-Baker Mk 4 ejection seats. Although intended for primary training, a full complement of blind-flying instruments is fitted, including a gyro-magnetic compass, as well as D.M.E. and V.H.F. or U.H.F. radio.

A detailed description and cutaway drawing appeared in *Flight* for June 13 last year, and a handling report by two of *Flight's* pilots appeared on May 31, 1957. A procedure trainer for learning cockpit drill is also being produced by Hunting. An armed Jet Provost mounting two 0.303in guns and pylons for rockets and bombs is available, and a number of these are being supplied to the Royal Ceylon Air Force.

Pembroke This is the military version of this twin-Leonides multi-purpose aircraft, which has been steadily improved since 1952. It is in service with seven air forces in a variety of rôles.

President This is the 12-seat civil variant, for airline or executive (6-8 seats) operation, of the military Pembroke transport currently in service with the R.A.F. and seven other air forces. Powerplant: two Alvis Leonides 504/5A engines of 540 h.p. each.

Hunting H.107 A project only, the H.107 is a small twin-jet (Bristol Siddeley Orpheus) airliner carrying 40-48 passengers for operation on ultra-short stages. Gross weight, 41,500 lb; max. payload, 10,960 lb; cruising speed, 400 kt.

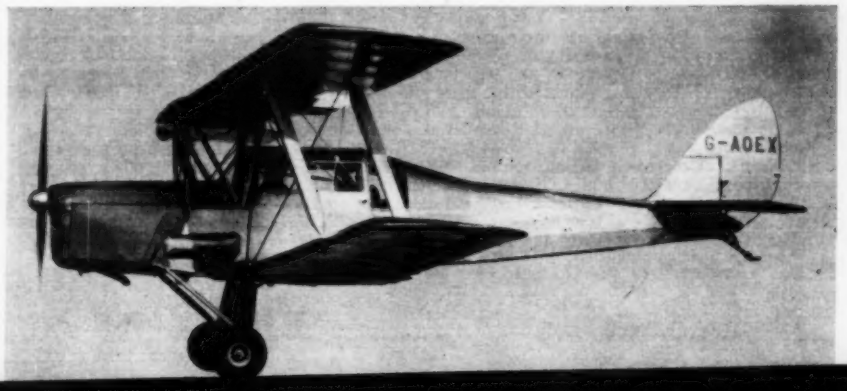
JACKAROO AIRCRAFT LTD.

Thruxton Aerodrome, nr. Andover, Hants. Telephone: Weyhill 304

Jackaroo Some 98 per cent of the original Tiger Moth components have been retained in this four-seat conversion, and four different variants are available fitted either for four occupants or agricultural work and having either Gipsy Major 1c or 10 engines. Prices vary between £1,470 and £1,995, and starter, metal canopy and night-flying equipment are optional extras. A number have now been sold, both in England and abroad, and have proved to be useful, very easy to maintain and to have a reasonable performance.

Paragon Now being prepared at Thruxton is a very simple and cheap four-seat, low wing monoplane with fixed undercarriage and powered by a Lycoming 180 h.p. engine. Normal-category gross weight is to be 2,500 lb, cruising speed 120 m.p.h. and range 480 miles. The selling price, based on 50 aircraft produced in the first year, should be in the region of £2,500.

Jackaroo



LANCASHIRE AIRCRAFT CO. LTD.

Squires Gate Airport, Lytham St. Annes, Lancs. Telephone: Blackpool, South Shore 43061

Prospector Jigs and materials from the former Edgar Percival Aircraft factory at Stapleford Tawney, Essex, have been moved to the new Lancashire Aircraft factory at Squires Gate, where production of a developed version of the EP.9 Prospector is under way. The powerplant is now the more powerful Lycoming GO-480 delivering 295 h.p. at 3,400 r.p.m., geared to a Hartzell constant-speed, three-blade metal propeller. As was convincingly demonstrated at the Paris Salon in June, performance has been considerably improved, and take-off distance to 50ft at gross weight is 1,065ft. Cruising speed is 128 m.p.h. and stalling speed with flaps 35 m.p.h.

Prospectors are in service in many parts of the world. A pilot and five passengers can be carried, or four seats can be removed in two minutes to make room for loads up to 12ft 6in long distributed over the 45 sq ft of floor. The rear freight door permits straight-in loading and can be removed altogether to facilitate para-dropping or the carriage of very long loads. Agricultural hoppers, dispensers and spray bars can be fitted to carry 170 gal or 1,680 lb, and with the hopper in place two assistants can also be accommodated in the rear cabin. Two stretchers and an attendant can be installed in the main cabin with a walking patient next to the pilot. Standard-category gross weight is 3,700 lb, but this can be increased to 4,320 lb for agricultural work. Fuel capacity is 56 gal, giving a maximum range of 580 miles. The manufacturers claim that the fabric-covered, steel-tube fuselage and all-metal wing, as well as the rubber-in-compression undercarriage suspension, make for exceptional ease of maintenance and repair.

Lancashire Prospector

F. G. MILES LTD.

Shoreham Airport, Shoreham, Sussex. Telephone: Shoreham-by-Sea 2301

Student In many demonstrations the Student has shown itself to be a docile and manœuvrable aircraft, excellently suited to *ab initio* training. Powered by a Blackburn Maboré turbojet of 880 lb thrust, it has a slightly swept all-metal, shoulder wing, and a side-by-side two-seat cabin in the nose. Car-type doors at floor level allow easy access and can be jettisoned to facilitate parachute exit. Twin fins and rudders are mounted at the tips of a tailplane which carries balanced elevators with anti-servo tabs. Engine air is drawn in through a flush intake immediately aft of the cockpit and the jet issues above the rear fuselage. The retractable undercarriage has a steerable nosewheel, and tip tanks may be fitted.

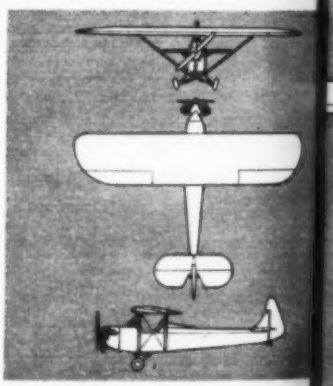
During a handling trial in June, C. M. Lambert of *Flight's* staff found the Student pleasant and straightforward to fly, providing an admirable blend of *ab initio* trainer and advanced jet aircraft characteristics. Take-off and landing distances on a tarmac runway were moderate, and aerobatics very pleasant to perform; stalls proved viceless. Although fully equipped (but not pressurized), the cockpit is simple and logical. Further versions with a variety of powerplants, either single- or twin-engined, have been mooted. Armament can also be fitted in the form of pylons containing 0.303in machine-guns and supporting rockets or bombs. Reports from America state that Miles are considering a four-seat, executive version of the Student with a more powerful engine.

Miles Student

PHOENIX AIRCRAFT LTD.

Cranleigh Common, Cranleigh, Surrey. Telephone: Bramley 2289

The company was formed comparatively recently to revive interest in the construction of the ultra-light Luton Minor and Luton Major, some pre-war examples of which are still flying. At the moment neither type is being built by the company itself, but a number of sets of plans have been sold for home construction both in Britain and abroad under the aegis of the Popular Flying Association. The Luton Minor is a single-seat parasol monoplane designed to be powered by the 37 h.p. Aeronca J.A.P. engine (or any aero engine of up to 42 h.p.). Total cost for home construction is estimated at about £250, including the engine, and the company offer advice and inspection services to help constructors obtain the necessary permit to fly. The Luton Major is an enclosed, tandem two-seat version powered by a 60-75 h.p. engine, such as the Mikron, Agusta, Continental A-65, Porsche or Pobjoy. A Luton Major would cruise at 95 m.p.h. and take off in 80 yd.



Phoenix Luton Minor

Rollason Turbulent

ROLLASON AIRCRAFT AND ENGINES LTD.

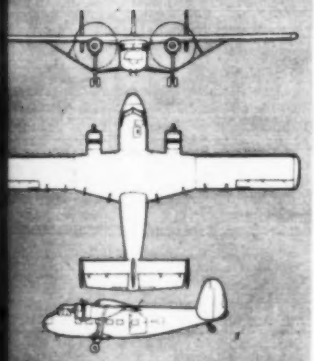
Croydon Airport, Croydon, Surrey. Telephone: Croydon 5151

Turbulent Production of the ultra-light, single-seat Turbulent by arrangement with M. Roger Druine and the Popular Flying Association is now well in hand at Croydon Airport. The company was formed in 1956 and concentrated on rebuilding and overhauling Tiger Moths. Subsequently a faster, more aerobatic Tiger with an inverted-flight fuel system was developed under the nickname Bishop; and an even more advanced version called Archbishop followed it. Rollason next embarked on the manufacture of the diminutive French ultra-light and no fewer than six of these aircraft were active in this year's national air races at Coventry. One of them was entered by the Duke of Edinburgh and was flown during the races by S/L. John Severne, the Duke's equerry (photograph, right). With a maximum authorized speed of 125 m.p.h., the Turbulent has a top speed at sea level of 88 m.p.h. and a stalling speed of 28 m.p.h. Empty and gross weights are respectively 350 lb and 620 lb. Rollason have themselves produced a modified version of the Volkswagen car engine called Ardem/4C02 which has dual ignition and a Solex carburetter and weighs 132 lb. Two Ardem versions are available, one producing 31 h.p. and the other modified to give 38 h.p. Prices of complete aircraft with these engines are respectively slightly under and slightly over £1,000. The Turbulent has fixed slots, slotted ailerons, a fixed undercarriage and tail-skid, an open cockpit with an ample windscreen and basic instruments. A blind-flying panel and other extras can be provided. The aircraft is particularly pleasant and responsive in flight.

SR-N1 Hovercraft

Saunders-Roe P.531 Mk 2

The Hovercraft, depicted above, has created tremendous interest in recent weeks—interest that promises to be further heightened by its appearance in the S.B.A.C. Display and by an important special feature to appear in the forthcoming issue of this journal (September 11)



Scottish Aviation Twin Pioneer CC.1

Powerplant	Two Alvis Leonides 514/8
Span	74ft 6in
Length	45ft 3in
Gross weight	14,000 lb
Cruising speed	126 m.p.h.

SAUNDERS-ROE LTD.

Osborne, East Cowes, Isle of Wight. Telephone: Cowes 2211

P.531 Having progressed in six months from drawing board to first flight, the P.531, powered by a Blackburn Turmo free-turbine of 425 s.h.p. has been in development for a year and a small batch is being supplied to the Fleet Air Arm for evaluation. Now the true Mk 2 production version powered by a Blackburn A.129 970 s.h.p. free-turbine (derated to 650 s.h.p.) has made its first flight, and the second Mk 2 with a similarly derated de Havilland Gnome H.1000 is almost complete. Take-off power will thus be maintained to considerable altitudes and temperatures. Gross weight has risen to 5,000 lb, with an equipped weight of 2,800 lb, and fuel tankage is increased to 160 gal. The new P.531 has a re-engineered transmission, new rotor blades (by Hordern-Richmond), a modified tail boom, fin and fixed tailplane and a skid landing gear. It is intended that the P.531 shall have full all-weather and navigation capability.

SR-N1 Hovercraft Saunders-Roe, under contract to the National Research Development Corporation, have built and tested an air-curtain vehicle based on investigations begun in 1956 by Mr. C. S. Cockerell. Weighing some 7,500 lb and powered by a single 515 h.p. Alvis Leonides, the present SR-N1 Hovercraft supports itself about a foot above ground or water by means of a curtain of air blown slightly inwards from annular slots around the periphery of the underside of the vehicle. Further air jets are provided for control and stability. The Hovercraft crossed the Channel on July 25 and is now being fitted with a propulsion engine. Studies are in hand for a 40-ton passenger version.

Skeeter Now in service with the British Army and the army and navy of Western Germany, the side-by-side dual control Skeeter is powered by a de Havilland Gipsy Major 215 h.p. engine to which water/methanol injection or a detachable turbo-supercharger may be applied.

SCOTTISH AVIATION LTD.

Prestwick Airport, Ayrshire. Telephone: Prestwick 79888

Pioneer In service with the R.A.F. for front-line tactical Army support, the Pioneer (Alvis Leonides) has proved most successful for light trooping, freighting and liaison out of short, rough forward strips. A revised version for the Army, powered by the long-stroke Leonides, is known as the Pegasus. The Pioneer has also rendered notable service in civil applications.

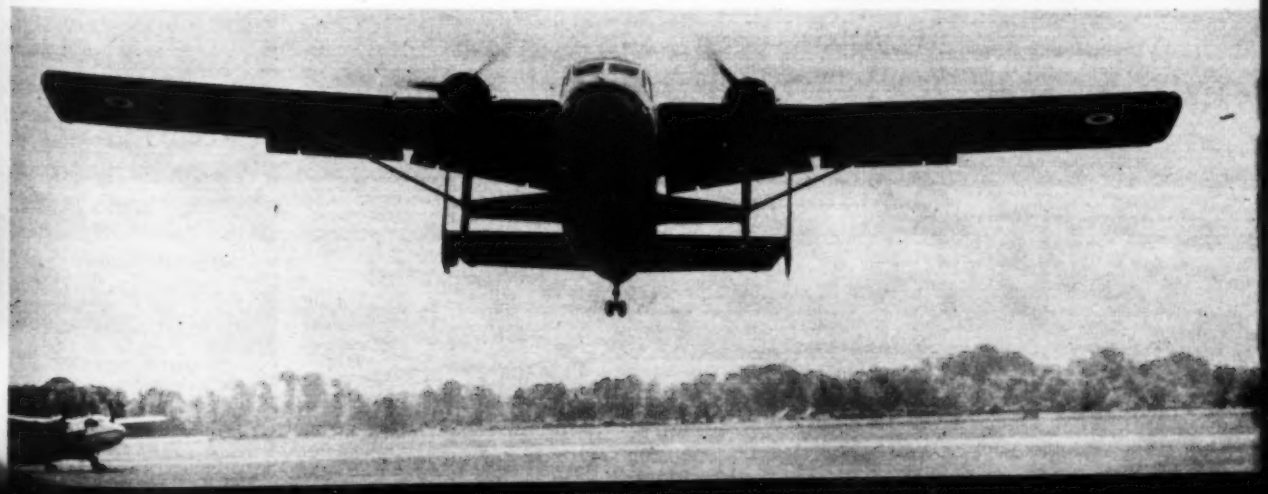
Twin Pioneer Series 3 The latest development of the Twin Pioneer is the Series 3, powered by two Alvis Leonides 531/8 piston engines developing 640 h.p. each, compared with 550 h.p. of the previous series. In service with the R.A.F. as the CC.1, and with a dozen commercial operators all over the world, the Twin Pioneer is a 16-passenger STOL transport capable of carrying, in its Series 3 form, a payload of 3,000 lb, over a still-air range of nearly 700 miles, out of unprepared strips 500 yd in length. At its maximum weight of 14,600 lb, the Twin Pioneer 3 requires a ground run to unstick (still air, sea level) of only 140 yd, and a landing run of little more than 200 yd.

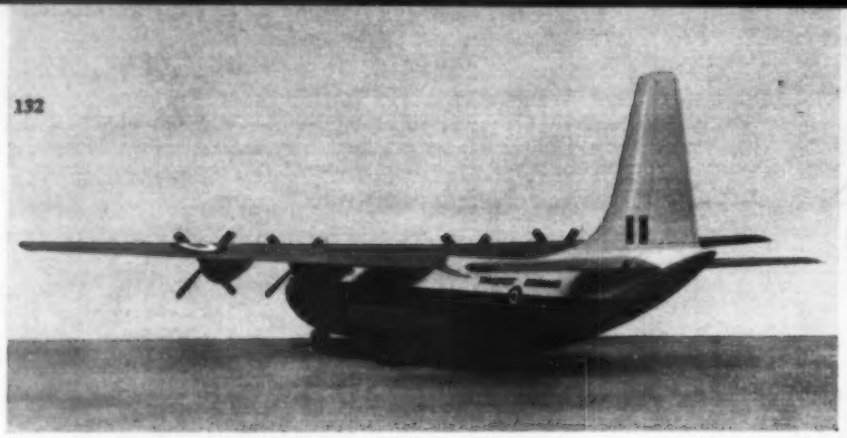
In its military rôle the Twin Pioneer's work is typified by this extract from *Flight* two weeks ago (August 21, p. 34):—

"A new Twin Pioneer squadron, No. 21, has been formed at R.A.F. Benson and is going out to East Africa next month to work with Army units of the Strategic Reserve in the light transport support rôle. This means primarily the movement of troops and their subsequent support, either by landings or air-drops (in the case of supplies; though the Twin Pioneer is also cleared for paratroop operations). Another duty is casualty evacuation. Reconnaissance and bombing could also be carried out if required."

In its civilian rôle, the Twin Pioneer is used in undeveloped areas for scheduled passenger and cargo work, air survey, ambulance, and general liaison and freighting. A special kit permits quick conversion to executive (6-8 seats) use.

Scottish Aviation Twin Pioneer CC.1





Short SC.5 Britannic

SHORT BROTHERS AND HARLAND LTD.

Queen's Island, Belfast. Telephone: Belfast 58444

SC.5 Britannic 3 Intended for initial operation by R.A.F. Transport Command, the big Britannic is Britain's first specialized transport aircraft for strategic, long-haul, all-freight operations. It is the most capacious and, after the VC.10, the heaviest land aeroplane now building in this country. Powerplant will be four Rolls-Royce Tyne RTy.12 turboprops of some 5,730 e.h.p. each. Delivery to the R.A.F. will be in 1964. The general layout—high wing, rear axial ramp-loading from truck-bed height—conforms to the classic concept of the all-freight transport designed for the rapid loading of bulky weapons and freight, and for the air-dropping of parachute troops and their supplies.

A typical military load could be a large radar installation, a ten-ton truck and a ¼-ton truck. Big missiles and guns could also be carried. The design field length at the maximum weight of 218,000 lb is 7,000ft, and the Britannic will be able to uplift its capacity payload of 85,000 lb over a stage distance of 1,150 statute miles at a cruising speed of 340 m.p.h., with 20 per cent fuel reserves. Alternatively, with a capacity fuel load of 81,200 lb the Britannic will be able to carry a 25,000 lb payload over 5,050 statute miles also at 340 m.p.h., and with ample fuel reserves.

Total cargo volume available in the rectangular section of the pressurized fuselage exceeds 10,000 cu ft, and including the rear ramp the hold is 80ft long, has a maximum height of 13ft 9in, and has a floor width of 12ft with a maximum width of 16ft 1in. The big sloping ramp door at the rear gives unhindered access to any load that these dimensions can contain.

Short SC.7 Still in the project stage in Short's new Light Aircraft Division, the SC.7 is a light general-purpose freighter designed to carry a 1½ ton payload—passengers or freight, including cars—off short runways.

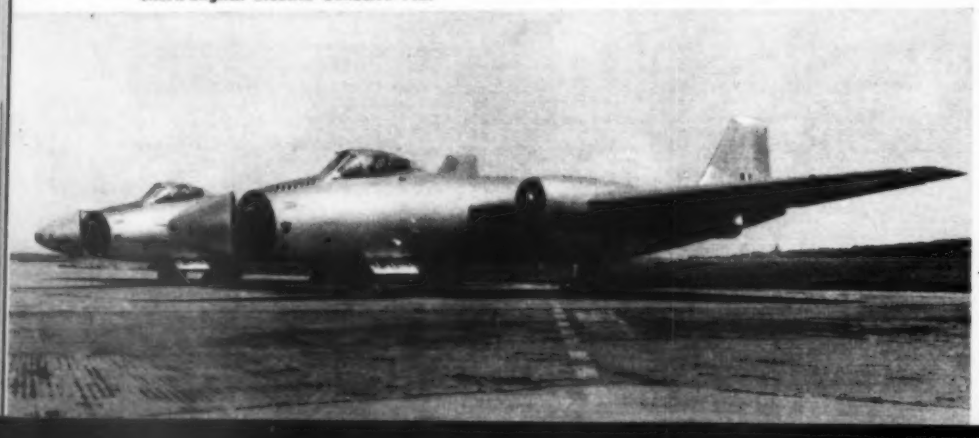
Canberra PR.9 The revised wing, with extended chord and span and powered ailerons, is now a familiar feature of this high-altitude reconnaissance Canberra. Production aircraft now emerging from the Short factory have an offset fighter-type canopy, and the complete nose swings open to give the navigator access to his ejection seat. Both radar and optical scanning equipment appear to be housed in the nose cap. Very powerful Rolls-Royce Avons and the new wing undoubtedly combine to give this Canberra variant exceptional high-altitude capability, and its military equipment is most comprehensive.

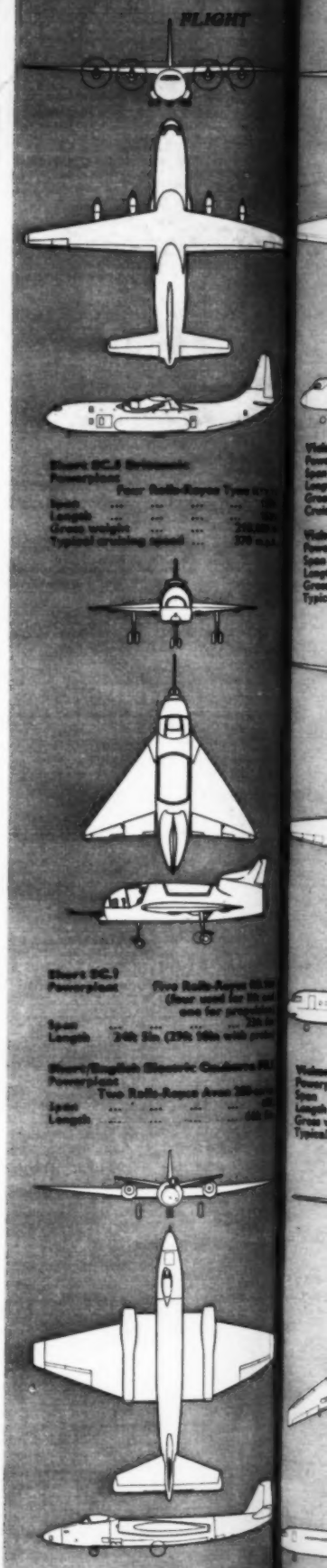
SC.1 Two examples of this jet-lift VTOL research aircraft are now flying, and the full translation cycle from hovering to forward flight is imminent. Some 10 hr of hovering have been completed in and out of the gantry and several hours of horizontal flight have proved the aerodynamic characteristics and have shown that the windmilling r.p.m. of the vertical engines can be accurately adjusted for relighting during forward flight.

The SC.1 is a single-seat delta-wing research aircraft with a fixed nosewheel undercarriage. Lift for vertical take-off is supplied by four Rolls-Royce RB.108 turbojets mounted vertically in the centre of the fuselage. These engines can be slightly inclined for initial translation; and air bled from them is vented from adjustable nozzles at nose, tail and wing tips controlled by an autostabilization system. Conventional aerodynamic controls are also provided for forward flight. A fifth RB.108, mounted horizontally in the tail, provides power for forward flight.

VTOL/STOL Fighter Revealed for the first time during the Paris Salon was a hypothetical lightweight strike fighter similar in layout to the SC.1 but employing eight lifting engines. Thrust for sea-level speeds up to M 0.98 would come from an afterburning turbofan engine. A one-ton weapon load could be delivered at low level over a radius of 250 miles, and the fighter would be supersonic at altitude.

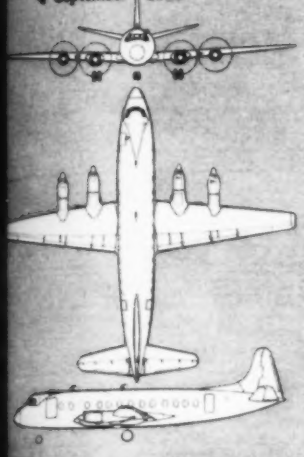
Short/English Electric Canberra PR.9





VICKERS-ARMSTRONGS (AIRCRAFT) LTD.

Weybridge, Surrey. Telephone: Weybridge 5555

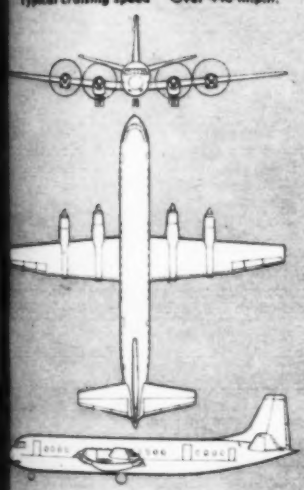


Vickers-Armstrongs Viscount 810

Powerplant	Four Rolls-Royce Dart 525
Span	93ft 8½in
Length	85ft 6in
Gross weight	72,500 lb
Cruising speed	365 m.p.h.

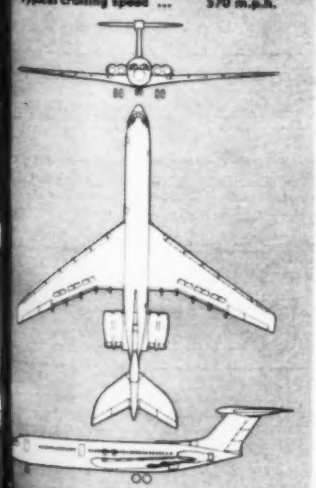
Vickers-Armstrongs Vanguard

Powerplant	Four Rolls-Royce Tyne
Span	118ft
Length	123ft 10in
Gross weight	141,000 lb
Typical cruising speed	Over 440 m.p.h.



Vickers-Armstrongs VC.10

Powerplant	Four Rolls-Royce Conway
Span	140ft
Length	160ft
Gross weight	Up to 310,000 lb
Typical cruising speed	570 m.p.h.



Viscount 810 This is the current production model of Britain's most successful commercial transport aircraft, production of which—in five distinct forms—is now giving way to the Vanguard after a run of more than 400.

The 810 represents almost the ultimate development of the prototype Viscount which, at approximately half the 810's weight and capacity, first flew in 1948. With a cruising speed of 365 m.p.h. and seating capacity for 75, the 810 still has the necessary structural reserves of strength to permit an increase of power, from the 1,800 s.h.p. of its Rolls-Royce Dart RDa.7/2 to the 2,660 s.h.p. which will be offered by the RDa.10 Mk 541. Such a conversion would increase cruising speed to 405 m.p.h., and in this form the 810 would become the 840. At least one 810 operator, Continental Air Lines of the U.S.A., is considering the possibility of such a conversion.

Other operators of Viscount 810s are Airwork, Sudan Airways, P.I.A., Lufthansa, T.A.A., Ansett-A.N.A., Cubana, S.A.A., and Hunting-Clan. A foreseeable future rôle for the 810 (and indeed for new production aircraft) is with ultra-high-density seating for short-stage local-service operations.

Vanguard In six months' time British European Airways expect to take delivery of the first of a fleet of 20 Vanguards. Within the next 12 months Trans-Canada Airlines will also receive the first of a fleet of 20.

Vickers have recently released an impressive study of the Vanguard's potential profitability on (1) U.S.A. routes, and (2) European routes. This study claims that the potential profit ability of a Vanguard over a period of seven years is $6½ million in U.S.A. operation and—because of the higher revenue rates—nearly $19½ million in European operation.

In U.S. domestic service, assumptions are a 300 statute mile sector and a passenger availability of as few as 48 people per flight in 1960, growing at a conservative 10 per cent a year; and an initial freight availability of 2,400 lb in 1960, also growing at an annual 10 per cent per year. With these initial loads (and a revenue rate of 5.34 cents per passenger st. mile, and 21.8 cents per freight ton-mile), a single Vanguard would make over 6½ million dollars profit in an operating period of seven years. Airlines with longer average stage lengths than 300 miles, and with average loads greater than 48 passengers in 1960, would naturally make considerably higher profits.

The basis of this analysis is the A.T.A. cost formula, which at the 300-mile point selected rates the Vanguard at 180 cents per aircraft mile. Vickers point to the fact that with both the Viscount V.745 and the Viscount V.812, the actual achieved costs in the U.S.A. have been significantly *below* the A.T.A. formula costs for those aircraft.

A previously published examination of the Vanguard in a 139-seat economy-class rôle has shown that at 65 per cent passenger load factor and no freight, the aircraft can make a 10 per cent profit at promotional fares up to 50 per cent cheaper than current European tourist rates, and at a fare average of 20 per cent cheaper than current U.S.A. coach class.

VC.10 In January 1958 B.O.A.C. signed a contract, valued at £60 million, for a fleet of 35 Vickers VC.10 long-range jet transports, with an option on a further 20, for delivery in 1963-1965.

Design and production-engineering work on this important new British transport has now advanced well into the detail stage, and a full-scale mock-up of the fuselage has been constructed. First flight will be in 1961.

Powerplant comprises four Rolls-Royce Conways of 17,500 lb thrust each mounted in pairs on each side of the rear fuselage. This arrangement leaves the wing completely unobstructed for such aerodynamic refinements as full-span leading-edge and trailing edge flaps. These contribute to the most notable feature of the VC.10 design in comparison with its Douglas DC-8 and Boeing 707 rivals—good airfield performance in high altitude and high temperature conditions. Since most world airports will be adequate for DC-8s and 707s, this advantage will be reflected in superior payload-range performance in such conditions. In addition, the rear engine installation will offer a high degree of cabin quietness.

Few details have been released; seating capacity is about 150; gross weight (1958) is 299,000 lb, though studies at 310,000 lb have been made; dimensions (other than those beneath the drawing) are: wing area, 2,800 sq ft; fuselage width, 12ft 4in; floor width, 11ft.

VC.11 A project only, about which no official details have been released, the VC.11 is a short-range jet "Viscount-replacement," details of which have been shown to foreign airlines (including United) during the past few months.

TSR.2 Not yet named, this exceedingly advanced manned delivery system for the R.A.F. is known merely by the initial letters of its function: tactical support and reconnaissance. Last January 1 the Minister of Supply announced that the main contract for it would be placed with Vickers-Armstrongs (Aircraft), who would share the work "on a 50-50 basis" with English Electric Aviation. A joint project team drawn from both companies has since been finalizing the basic design at Weybridge.

Although shrouded closely by security, many clues to the TSR.2 have already been let fall by

Vickers-Armstrongs Viscount 816

Vanguard

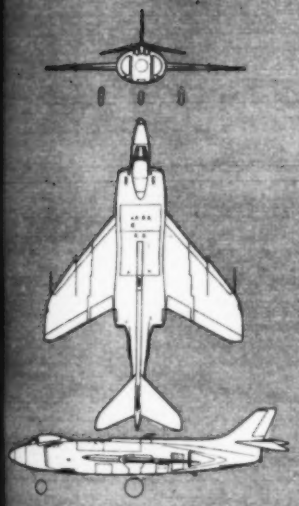
Vickers-Armstrongs VC.10

the Secretary of State for Air. In the original announcement it was stated that power would be provided by engines to be developed by Bristol Siddeley, and the recent revelation that an advanced version of the Olympus has a reheat thrust of 33,000 lb is surely not insignificant. The document continued: "The specification was originally based on General Operational Requirement No. 339. In the course of study it has been found technically possible to incorporate in the final Operational Requirement modifications which will greatly increase the usefulness of the aircraft in limited operations and for close support of the Army, particularly by reducing the length and strength of runways required for take-off. While the TSR.2 will be capable of performing the rôles of all the various marks of Canberra, it will, by reason of its greater flexibility and higher general performance, be far more versatile and more in the nature of a general-purpose tactical aircraft."

During February a question in the House of Commons elicited from the Secretary of State for Air the information that the aircraft would not be a VTOL but would operate from short runways and semi-prepared surfaces; these qualities, he said, would be achieved "by a combination of high engine power, advanced wing design and a special undercarriage."

Very much more was divulged during the debate on the Air Estimates on March 5. The Secretary of State then said:

"What, then, must be the basic features of the TSR.2? It must be able to carry a useful bomb load and have a radius of action of at least 1,000 miles. This range implies flight at high level for a considerable part of the time, and to survive at high altitude the aircraft must be able to fly at high supersonic speed. At the same time, it must be capable of flying at around the speed of sound at low altitude. It must also be able to use short runways with unprepared surfaces; to carry the navigating and bombing equipment to enable it to find and attack accurately tactical targets by day and by night in all weathers; and to give Army support in a variety of situations. Remarkable technical advances will enable this new aircraft to take-off on operational missions using as little as 600 yards of runway, and it is clear that the electronic equipment for accurate navigation, bomb-aiming and reconnaissance can be developed, although it presents many problems. This combination of characteristics will certainly be unsurpassed and possibly unequalled in any aircraft known to be in the design stage today. The result will, I am sure, be an aircraft which will be just as admirable in its generation as the Canberra has been, and just as flexible in its variety of uses."

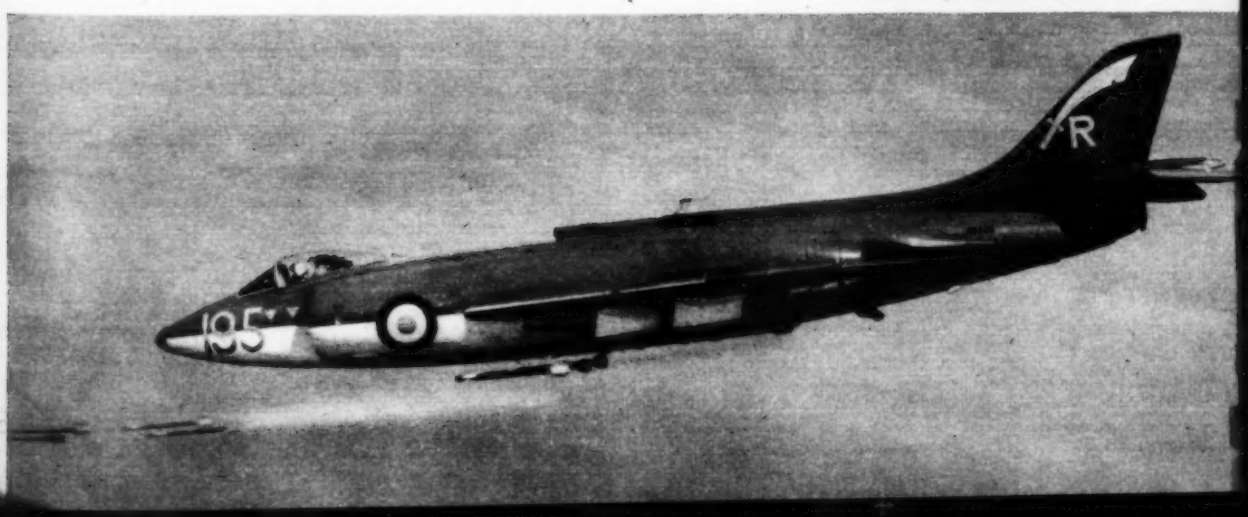


Vickers-Supermarine Scimitar F.1
Powerplant: Two Rolls-Royce Avon 200-series
Span 37ft 2in
Length 56ft 2in

Supermarine Works

Scimitar A number of squadrons of Scimitar single-seat strike fighters have been formed in the Fleet Air Arm, and on several occasions these formations have gone to sea. Powered by two Rolls-Royce Avon 200-series engines mounted beside the fuselage, the Scimitar can reach sonic speed at sea level. It has a swept wing with a drooping leading-edge and saw-tooth extensions. Approach speed is reduced by compressor-bled air blown from span-wise slots over the top of the flaps, blowing starting automatically when the flaps are lowered more than 10 deg. Controls are fully powered and the slab tailplane has marked anhedral. Radar-ranging and a semi-automatic navigation device, in addition to flight refuelling and considerable internal and external tankage, make the Scimitar a very potent strike aircraft. Conventional and tactical atomic bombs can be delivered with LABS. Conventional rockets can be attached on four under-wing pylons, and the installation of air-to-air guided weapons has been investigated. A Scimitar last year flew from London to Malta non-stop at an average speed of 588 m.p.h.; all-round performance, and especially rate of climb, are very high indeed. For carrier stowage the wings and the nose both fold. A large arrester hook and tail-bumper retract into the rear fuselage.

Vickers-Supermarine Scimitar F.1



WESTLAND AIRCRAFT LTD.

Yeovil, Somerset. Telephone: Yeovil 1100

Wessex Following successful trials last year of a Sikorsky-built S-58 fitted with a Napier Gazelle NGa.11 free-turbine engine giving 1,120 s.h.p., production versions are now being produced entirely by Westland powered by the NGa.13 delivering 1,450 s.h.p. They will become the standard Royal Navy anti-submarine equipment. The Gazelle is some 600 lb lighter than the 1,525 h.p. Wright Cyclone which is standard for American machines, and also has the advantage of not requiring high-octane petrol—by burning standard naval turbine fuel. A B.T.H. isopropyl nitrate starting system is fitted. Two groups of bag tanks are located underneath and immediately ahead of the main cabin; an extra 30-gal tank can be added to the rear group to raise the internal capacity to 300 Imp. gal, and external drop-tanks can be carried on crutches on either side of the aircraft. Disposable load, including fuel and crew, is 5,000 lb, allowing the carriage of more than 20 troops. The Gazelle powerplant is made to A.R.B. specifications and Westland can justifiably look forward to civil sales in the future. Present production is entirely for the Royal Navy, for whom the Wessex will carry both detection equipment and weapons. It is probable that an auto-pilot and positive hovering control will be provided to simplify all-weather search operations. The entire tail end and blades of the main rotor fold for carriage stowage.

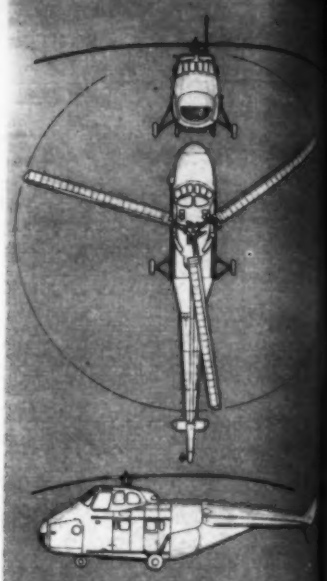
The Gazelle drives the main rotor at 222 r.p.m. for an engine speed of 17,000 r.p.m. Accessories mounted on the main gearbox include an oil-cooler, two hydraulic pumps for duplicated flying controls and winch, an oil pump, a 12 kW generator and its cooling fan and the rotor-head tachometer. Since no warm-up is required the Wessex can be airborne 30 sec after the starter is energized.

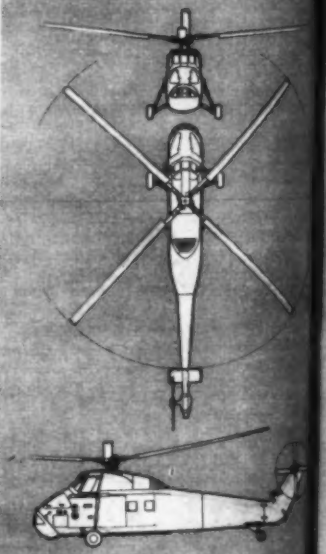
Whirlwind Various versions of this Alvis Leonides Major-powered helicopter have been produced for the Army, the R.A.F., the Fleet Air Arm and numerous military and civil foreign customers. Typical rôles are rescue, transport and anti-submarine work—the latter with dunking sonar and a homing torpedo accommodated in a trough beneath the fuselage. Last year the Whirlwind was flown powered by G.E.T58 turbine, and an installation of a de Havilland Gnome (the Anglicized T58) is complete. The Gnome considerably increases performance and payload (from 1,254 to 1,846 lb) and might be retrospectively fitted to existing Whirlwinds.

Widgeon Fitted with the Alvis Leonides engine and a Whirlwind four-blade main rotor, this Westland development of the earlier Dragonfly has a redesigned forward fuselage and can accommodate five people or freight. Two stretchers may be loaded through a nose hatch, and a variety of furnishing schemes and a hydraulic winch capable of lifting two people simultaneously can be provided. Widgeons are operating in various parts of the world, including Brazil.

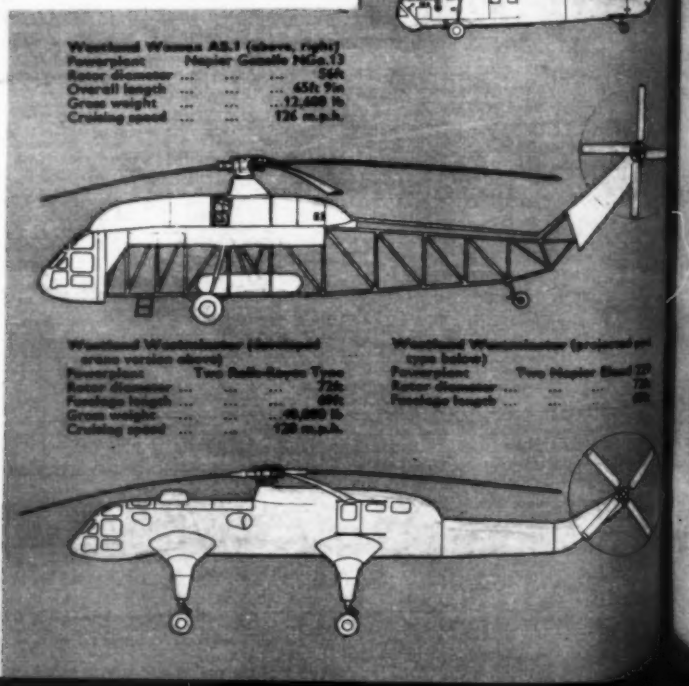
Westminster The first Westminster—virtually a steel-tube space frame carrying two Napier Elands and a fully engineered cockpit, and having a Sikorsky S-56 rotor and transmission and Sikorsky tail—has now been flying very successfully for more than a year. A second machine is about to fly; both the first and second are currently powered by Eland E.229A engines giving 3,150 s.h.p. each. The second machine is structurally slightly refined, has laterally mounted fuel tanks, a completely cowled powerplant, transmission and pylon, with built-in maintenance platforms, and specially designed Dunlop wheels and brakes (which are some 300 lb lighter than the Bristol Freighter wheels adapted for the first machine). Recently revealed is a crane version—dubbed the "Pod Westminster"—with the cockpit mounted ahead of, instead of below, the engine intakes, a fully skinned fuselage with a cabin aft of the rotor pylon and an undercarriage with four legs of sufficient length to leave clearance for a large underslung cargo container. A mock-up exists of a 40-seat passenger airliner which could cruise at 150 m.p.h. for 100 miles with reserves. As shown in a drawing, advanced versions could have Rolls-Royce Tyne engines.

Elands are fixed-shaft engines, and in the Westminster both drive into a common transmission shaft at a constant speed, load variations caused by rotor pitch changes governing the power demand. To prevent differential fluctuation in engine r.p.m. from putting the full load on either engine, hydraulic clutches are inserted with a constant slip of two per cent. Various transmission speeds can be selected in the cockpit, and failure of one engine would immediately cause the other engine to absorb the full load without time lag and without any action by the pilot. Rotor controls are fully powered by a duplicated hydraulic system, and the second machine has full dual control.





Westland Wessex AS.1



FLIGHT, 4 September 1959

Westminster Prototype

Elliotts Olympia 401

Sailplanes

ELLIOTTS OF NEWBURY LTD.

Albert Works, Newbury, Berks. Telephone: Newbury 312

Now under development at Newbury for the standard class of next year's World Gliding Championships is a new 15-metre sailplane, using the same laminar-flow wing section as the Series 4 Olympias but with a completely redesigned fuselage. This aircraft will obviously benefit from the company's experience with the various 15-metre Olympia 4s. The only Series 4 model in production at present is the 419, which sells at a basic price (no instruments) of £2,150. Completion of the present batch of six will bring the total of 419s built to ten.

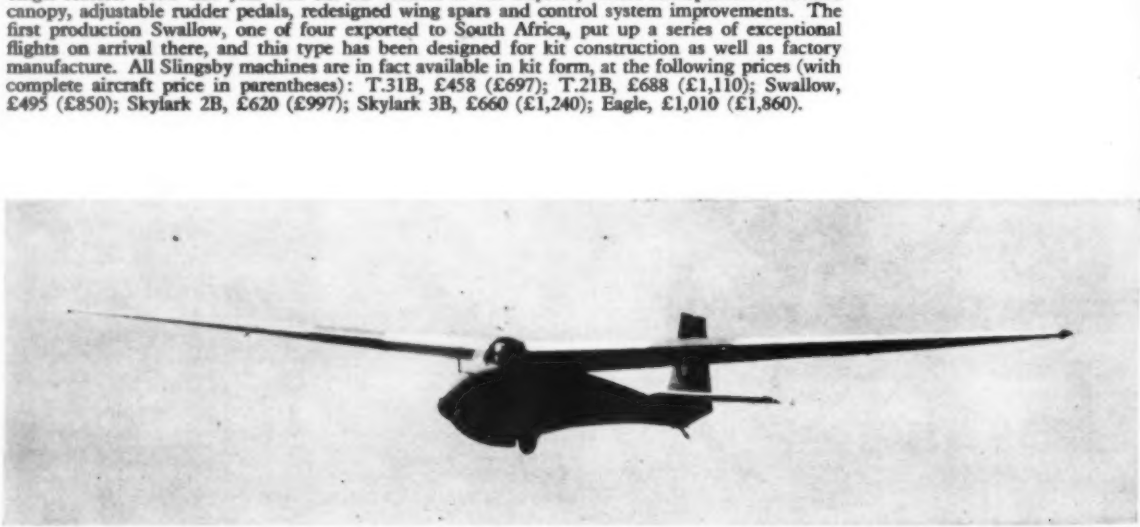
Another current product is the well-known Olympia 2, of which a second batch of 24 is now being built at a basic price of £800. At the National Gliding Championships at Lasham this year Elliott-built entries included the 15-metre Olympia 401, the 17-metre 403 and 19-metre 419s.

SLINGSBY SAILPLANES LTD.

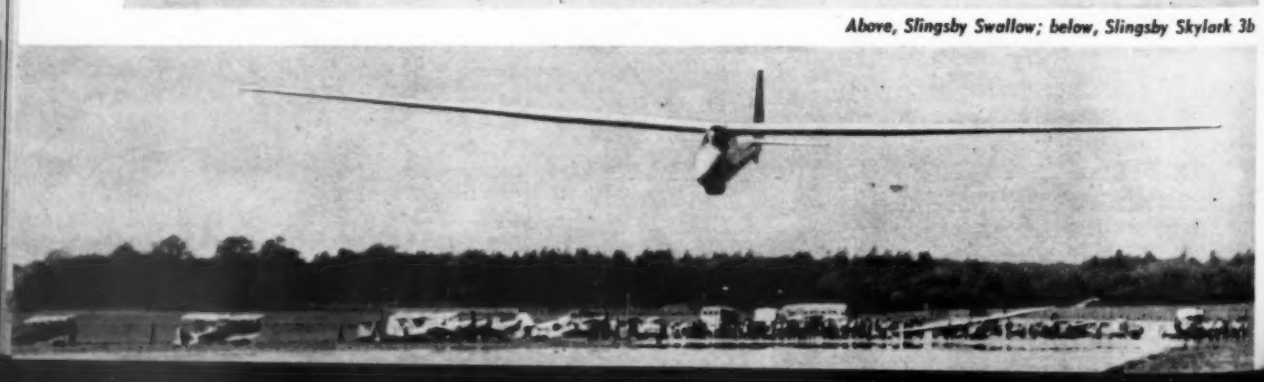
Kirbymoorside, Yorkshire. Telephone: Kirbymoorside 312

A fundamental change in the ownership of Slingsby Sailplanes took place at the beginning of this year, with the formation of the Shaw Slingsby Trust Ltd., which now owns the entire share capital of the company. With F. N. Slingsby continuing as managing director of Slingsby Sailplanes, Philip Wills is now chairman both of the company and of the new trust, which intends to support the British gliding movement in a similar manner to that of the Kemsley Flying Trust.

The current range of glider types in production at Kirbymoorside consists of the T.31B and T.21B basic trainers, T.42 Eagle advanced trainer, and the Skylark 2B, Skylark 3B and Swallow single-seaters. New this year was the 2B version of the Skylark, which incorporates a revised canopy, adjustable rudder pedals, redesigned wing spars and control system improvements. The first production Swallow, one of four exported to South Africa, put up a series of exceptional flights on arrival there, and this type has been designed for kit construction as well as factory manufacture. All Slingsby machines are in fact available in kit form, at the following prices (with complete aircraft price in parentheses): T.31B, £458 (£697); T.21B, £688 (£1,110); Swallow, £495 (£850); Skylark 2B, £620 (£997); Skylark 3B, £660 (£1,240); Eagle, £1,010 (£1,860).



Above, Slingsby Swallow; below, Slingsby Skylark 3b



British Aero Engines 1959

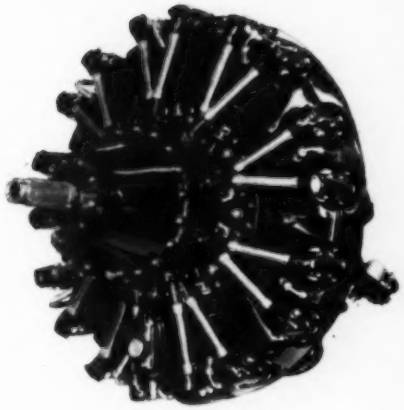
ALVIS LTD.

Holyhead Road, Coventry. Telephone: Coventry 25501

Leonides In production for many years as the only British aero engine in the 500 h.p. class, this attractive single-row radial-engine family has now been revitalized by the introduction of a range of uprated powerplants in which the piston stroke has been increased from 4.41in to 4.8in (resulting in a "square" engine). Total flight time of the Leonides family is now approaching 3m hr in a total of 38 countries.

Like their predecessors, the long-stroke engines are available in both aeroplane and helicopter forms, the latter being equipped for direct drive through a 16in centrifugal clutch and cooling fan and being capable of installation with the crankshaft vertical, horizontal or at an intermediate angle. A single-stage single-speed supercharger is normally fitted, together with an injection-type fuel pump, and either electric or cartridge starting may be provided. Data for the fixed-wing engine are given below the photograph; a typical helicopter version is the Leonides 554/1 which weighs 790 lb and has a maximum rated power of 635 b.h.p. at 3,200 r.p.m. at 2,500ft with 7.5 lb/sq in boost.

Leonides Major The Major has 14 of the original short-stroke Leonides cylinders disposed in two staggered rows on a common crankcase. Originally produced for fixed-wing transports, it is now in production as an any-attitude helicopter engine. The Leonides Major 755/1 weighs 1,110 lb and has a maximum rated power of 795 b.h.p. at 2,900 r.p.m. with 6.5 lb/sq in boost. It is in service with Westland Whirlwind HAS.7 helicopters of the Royal Navy and with S-55 Series II helicopters of the Austrian Air Force. The same powerplant has also been selected for the Whirlwind Mk 8 helicopters for the Queen's Flight.



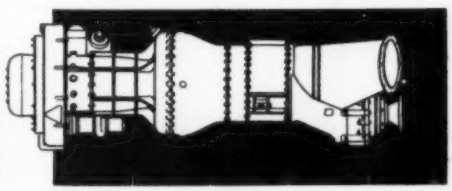
Alvis Leonides 531/8 Fixed-wing piston engine. Nine cylinders, with single-speed gear-driven supercharger and geared propeller drive. Overall diameter, 43in; length, 54.4in; bore and stroke, both 4.8in; swept volume, 783 cu in; dry weight, 860 lb; maximum sea-level rating, 640 h.p. at 3,200 r.p.m. with boost pressure of 8 lb/sq in.

BLACKBURN ENGINES LTD.

Brough, Yorks. Telephone: Brough 121

A.129 Development of this very attractive free-turbine engine in the 1,000 h.p. class is proceeding in a most satisfactory manner. As is now well known the engine consists essentially of the basic gas-generator of a Turmo (q.v.). To this fully developed heart has been added an entirely new two-stage axial compressor which substantially increases the pressure ratio, and hence permits the engine to give much higher power for only a modest increase in weight (while at the same time significantly improving the specific fuel consumption). Following Blackburn's established practice, it is the company's intention to make the basic A.129 the founder of a family of related powerplants in the 970 s.h.p. category.

The first development A.129 ran on the bed one year ago. The programme is exactly on schedule; the first two units have now logged well over 600 hr development running, other A.129s have completed several 25 hr special-category tests and one engine has started its flight trials fitted to the first Saunders-Roe P.531 Mk 2 helicopter. In the P.531 the engine is mounted horizontally but in the second installation, the Westland Whirlwind, an A.129 is currently being installed at an angle of 45 deg. Discussions are being held with other helicopter manufacturers and one of the most attractive aspects of the A.129 is that it is confidently expected that a complete powerplant will cost considerably less than £10,000.

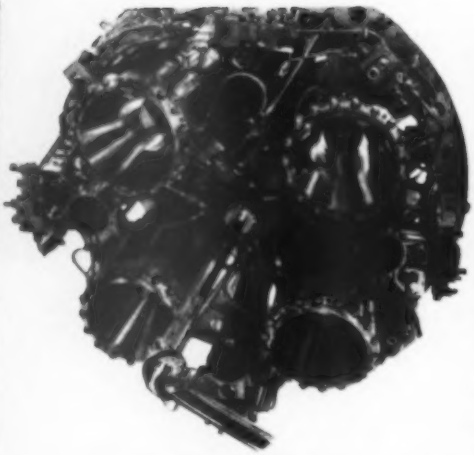


Blackburn A.129 Mk 3 Company-sponsored turboshaft engine. Compressor with two axial stages followed by single centrifugal stage, annular combustion chamber with fuel injection from rotary spray, two-stage compressor turbine and single-stage power turbine. Max installational diameter, excluding exhaust duct, 20.062in; intake diameter, 14.625in; overall length as depicted, 62.66in; dry weight, including fuel, oil and ignition systems, reduction gearbox and bifurcated exhaust duct, 390 lb; max rating, sea level, static, i.s.a., 968 s.h.p.+93 lb thrust at 35,000 compressor r.p.m. and 30,000 power-turbine r.p.m. with s.f.c. of 0.681 lb/hr/s.h.p.; max cont. rating, same conditions, 815 s.h.p.+82 lb at 34,000/28,100 r.p.m. with s.f.c. of 0.718.

Turmo As the basic Blackburn free-turbine engine the Turmo has been produced in limited quantities at ratings of around 450 s.h.p. and is currently flying in Saunders-Roe P.531 Mk 1 and Kaman K-17 helicopters. In its standard form the Turmo 600 weighs some 310 lb with a rear-mounted gearbox, and has a maximum continuous rating of 366 s.h.p.

Palouste The function of this small gas turbine is the supply of a large volume flow of compressed air, usually at a gauge pressure of some 42 lb/sq in. It is used as the powerplant of the Fairey Ultra-Light helicopter, feeding air to the pressure jets at the blade tips. The Palouste is also in quantity production for installation in ground-starter trolleys for the Royal Navy and several other military and commercial customers.

Bristol Siddeley Thor BT.1 Supersonic ramjet for propulsion of the Bloodhound surface-to-air missile. Twin-shock intake, ram-driven fuel turbopump feeding annular injection manifold and convergent/divergent fixed-geometry nozzle. Overall diameter, 15.75in; length, 94.5in; approximate equivalent horse-power, 130,000 at Mach 3 at sea-level; all other data are restricted.



Bristol Siddeley Gamma Mk 201 Liquid-propellant rocket propulsion package, with four gimbal-mounted chambers each individually fed by its own turbopump with H.T.P. and kerosine. Overall diameter, 36in; length as depicted, 38in; dry weight of complete engine compartment, approximately 700 lb; thrust rating, 16,400 lb at sea level, rising to over 19,000 lb at altitude.

BRISTOL SIDDELEY ENGINES LTD.

P.O. Box 3, Filton, Bristol. Telephone: Filton 3871
P.O. Box 17, Coventry. Telephone: Coventry 62666

BE.53 Last June Bristol Siddeley announced from Filton that an entirely new family of ducted-fan engines was being developed for military and civil applications. For obvious reasons, engineering details of these powerplants are being withheld; but it is logical to assume that they make the maximum use of major assemblies—compressors, combustion systems and turbines—of the turbojets already fully developed.

The BE.53 is a military member of the new family. According to the company "the air is used to provide both direct lift and forward thrust. In addition the air can be used for 'blown flaps,' for boundary-layer control, etc." This at once suggests that the cool fan air and hot jet are ducted to alternative nozzles according to the flight regime of the aircraft in which the engine is installed. One of the new Bristol Siddeley fans is "being developed under the auspices of MWDP for use in aircraft intended for NATO forces." It seems logical to assume that this engine is in fact the BE.53, and that its application is the Hawker P.1127 VTOL strike/fighter (page 127).

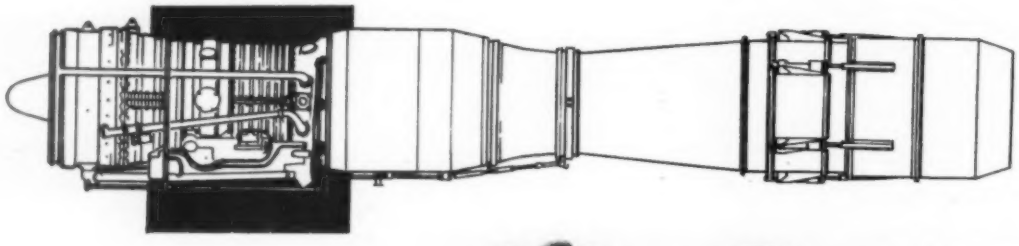
BE.58 Another of the company's new family of ducted fans, the BE.58 is a private venture for commercial purposes. For this reason some information concerning its design has already been divulged, and a display engine is to be exhibited at Farnborough. Although Bristol Siddeley emphasize that the BE.58 is an entirely new engine and not "an adaptation of existing units," a large number of the components of the new fan family are very similar to those of the Orpheus and Olympus.

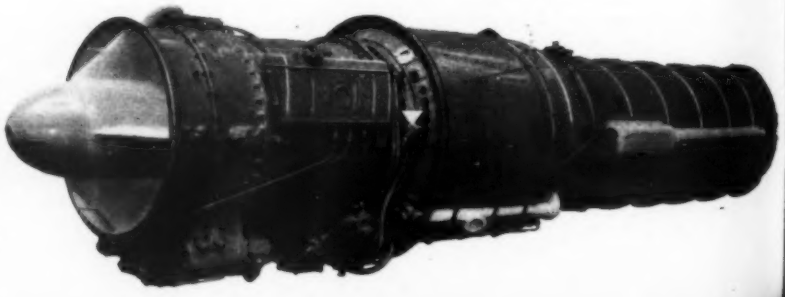
A ducted-fan engine can be regarded as bridging the gap between the turbojet and the turboprop; and, according to the cold-flow ratio chosen, it can be made to have characteristics at any point between these two extremes. In the case of the BE.58 the cold-flow ratio is very high, lying between 1.5 and 2 (i.e., the flow through the fan is more than one and one-half times the hot flow through the gas-generator portion of the engine). This means that the engine is matched to subsonic transport applications, and in comparison with an equivalent turbojet it promises to offer a cruising specific consumption at least ten per cent better and to have a noise level from 10 to 15 decibels lower. No specific details of the engine may yet be published, but Bristol Siddeley described its design thrust as being "similar to the Olympus series," suggesting ratings in the 14,000 to 17,000 lb class. Moreover, the company make the assertion that the thrust/weight ratio of their new fan engines "is better than that of any turbojet in the same thrust class."

Gamma The unblemished firing record of the Black Knight upper-atmosphere and re-entry research vehicle owes much to the outstanding reliability of its Gamma rocket engine. The Gamma has four gimbal-mounted combustion chambers operating on H.T.P. and kerosine, each chamber having its own turbopump unit. The vehicle is controlled by hydraulically pivoting the chambers in unison or in opposition, and the H.T.P. supply is fed at high pressure through the hollow trunnions which support each chamber. The basic design of the chamber was undertaken by the Royal Aircraft Establishment, and the complete powerplant was developed by Bristol Siddeley's rocket division at Ansty near Coventry.

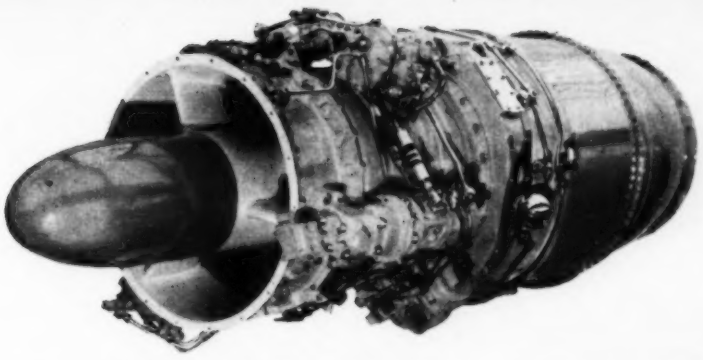
Olympus First run in 1950, the Olympus was the world's first two-spool turbojet, mechanical separation of the main rotating assembly into high-pressure and low-pressure units permitting a very high pressure ratio to be achieved with excellent engine-handling. Nearly all the Olympus so far delivered have been of the first-generation 100 series. Engines of this family went into production in 1955 at a dry rating of 11,000 lb and final

Bristol Siddeley Olympus BOl.7R Military two-spool turbojet with afterburner. Inspection shows that there is a five-stage low-pressure compressor, seven-stage high-pressure compressor, can-annular combustion chamber with eight flame tubes, single-stage h-p. turbine, single-stage l-p. turbine, fully variable afterburner and multi-position nozzle. Overall intake diameter, 36.55in; installational envelope diameter, 42in; length as depicted, cold, 295.64in; max reheat rating, 24,000 lb (more advanced engines have a reheat rating of 33,000 lb); type-tested dry rating, 17,000 lb. The weight of the non-reheat engine has been stated to be 3,600 lb.





Bristol Siddeley Orpheus BOr.12SR Single-shaft turbojet. Seven-stage compressor, annular combustion chamber with seven burners, single-stage turbine and simplified reheat system with two-position nozzle. Overall diameter, 32.4in; length, to exhaust flange, 81.4in; length, including reheat jetpipe, 181.4in; dry weight, 1,110 lb; weight of equipped powerplant together with reheat jetpipe and variable nozzle, 1,479/1,560 lb; maximum thrust, 8,170 lb with s.f.c. of 1.62; dry rating, 6,810 lb with s.f.c. of 0.967.



Bristol Siddeley Viper 11 Military single-shaft turbojet. Seven-stage compressor, annular combustion chamber with 24 vaporizing burners and single-stage turbine. Overall diameter, 24.55in; intake external diameter, 18.5in; length, exclusive of nose bullet, 63.7in; dry weight, 500 lb; max rating, 2,460 lb dry at 13,400 r.p.m. with mass flow and pressure ratio of 42 lb/sec and 3.85:1 and s.f.c. of 1.115.

deliveries of the Olympus Mk 104 were rated at 13,000 lb. As the powerplant of the Vulcan B.1, a large number of 100-series Olympus are in R.A.F. service; they are at once the R.A.F.'s most powerful, most efficient and most reliable combat engines, with the highest overhaul life and lowest premature-removal rate. It has also been officially acknowledged that the handling characteristics of these powerplants are superior to those of any other engine in the world, particularly at altitudes above 50,000ft.

Production is now being concentrated upon the largely redesigned 200-series engine. While retaining a carcase similar in size to that of the earlier units, these new engines are designed to take advantage of recent improvements in aerodynamics and thermodynamics; the number of stages on both compressor spools has been reduced, thus effecting a substantial reduction in engine weight, while retaining an approximately similar pressure ratio. At the same time the mass flow has been very greatly increased so that the dry thrust of the current Mk 201 version is no less than 17,000 lb. Engines of this general family are fitted to the Vulcan B.2, and portions of these units have doubtless been incorporated into the new Bristol Siddeley ducted-fan family.

Development has also been proceeding upon a special range of Olympus fitted with an afterburner for supersonic propulsion. It is known that the powerplant of the forthcoming TSR.2 aircraft will be an advanced Bristol Siddeley turbojet. It seems fair to assume that this engine will in fact be the ultimate version of the supersonic reheat Olympus family. One of these has been fitted with Bristol-Solar fully variable reheat, giving a maximum static thrust of no less than 33,000 lb.

Orpheus Originally planned as a medium-thrust turbojet to replace such centrifugal engines as the Nene, the Orpheus has achieved success in such diverse types of aircraft as trainers, transports, transonic fighters and ground-attack machines. From the outset the engineering design has been weighted heavily in favour of simplicity, low cost and easy maintenance; and the rapid development of the Orpheus, and its outstanding performance in arduous service, underlines the rightness of the concept.

At present the most numerous Orpheus are 5,000 lb thrust engines of the Mk 803 variety, which are fitted to the Fiat G.91s used by several NATO Air Forces (the outstanding serviceability of which aircraft is fast becoming a byword). A related engine is the 4,700 lb thrust Mk 701, fitted to the Folland Gnat lightweight intercepter; and a special version for training purposes, characterized by increased robustness and a rating reduced to 4,230 lb, is the Mk 100 fitted to the Gnat Trainer.

Development is proceeding upon slightly enlarged engines, of which the first example is the BOr.12. The basic BOr.12 is rated at 6,810 lb dry, and with "simplified reheat" has a maximum rating of 8,170 lb. First run on the bench late last year, it achieved its full reheat rating 12 weeks later and is shortly to take the air as the powerplant of a Sabre. Production BOr.12s will be available next year for such aircraft as the Bréguet Taon and for certain supersonic intercepters. Special transport Orpheus have also been projected, incorporating such refinements as thrust reversers and two-position nozzles to match the engines to take-off or cruising flight regimes. Doubtless the Orpheus also forms the basis of some of the company's new family of fan engines.

PR.23 Developed at Ansty by the company's rocket division, the PR.23 is an exceptionally small and compact liquid-propellant rocket package intended for a variety of applications—the most important of which is presumably the vernier propulsion of large ballistic vehicles. The unit comprises a rigid frame—which can be mounted on gimbals if necessary—housing a single chamber fed with H.T.P. and kerosine. The complete package weighs 32 lb; maximum sea-level rating is 500 lb, and the unit can be throttled to around 150 lb thrust with only a slight reduction in specific impulse.

Proteus Since its introduction to passenger-carrying service in February 1957, the original Proteus 705 has logged almost half a million hours and currently has an overhaul life of 2,000 hr. The more powerful Proteus 765, fitted to current Britannias, is entering service with an initial life of 850 hr and a maximum rating of 4,400 e.h.p. Shortly to be available is the Proteus 770, in which maximum power has been raised to 4,615 e.h.p.

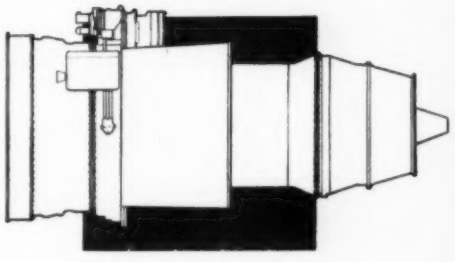
Sapphire The latest and most powerful version of this excellent single-shaft turbojet is the ASSa.7R, which, with simple reheat, has a rating of 12,230 lb. It is fair to assume that engines of this type are fitted to the latest marks of Javelin all-weather fighter.

Thor Permission has now been granted for Bristol Siddeley to display a sectioned ramjet, and an early Thor BT-1 will be so exhibited at Farnborough. This engine was fitted to the initial production Bloodhounds used during R.A.F. service acceptance trials at Woomera. A more powerful version of Thor is now in production for the Bloodhound missile, and larger engines—doubtless designed for still higher supersonic Mach numbers—are at present in various stages of development.

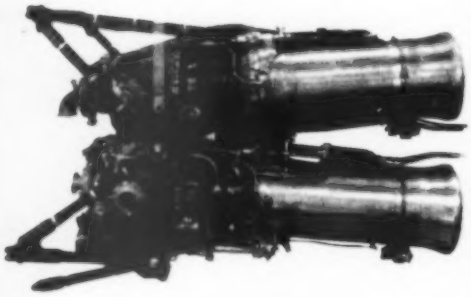
Viper Originally a short-life engine of 1,640 lb thrust for the early Jindivik targets, the Viper has been progressively increased in mass flow and top temperature until the ASV.11 long-life engine is now in production at 2,500 lb. The ASV.11 has been ordered in quantity for the Italian Macchi MB.326 Trainer and for the Jindivik Mk 3 supersonic drone. The bulk of Vipers currently in service are of the ASV.8 type, rated at 1,750 lb thrust and fitted to the Hunting Jet Provost and Jindivik Mk 2B. At present the ultimate development of the Viper is the ASV.12, in which minor improvements have permitted the maximum rating to be established at 2,700 lb.

Bristol Siddeley PR.23 Liquid-propellant rocket motor. Single, fixed, regeneratively cooled chamber fed by turbopumps with H.T.P. and kerosine from remote tankage, mounted in one package complete with control system. Overall enclosing diameter, 8.25in; nozzle external diameter, 4.25in; overall length, 39in; dry weight, 30 to 32 lb; thrust, variable from 500 to 800 lb at sea level; specific impulse, 207 at sea level, 250 at 30,000ft and 264 at 60,000ft.

Bristol Siddeley BE.58 Turbofan engine with multi-stage low-pressure fan compressor, multi-stage high-pressure compressor, can-annular combustion chamber and independent high- and low-pressure turbines. No quantitative information may be quoted for this engine, but inspection shows that the intake diameter is some 48in, the overall height (including alternator) about 69in and the length, as depicted, about 126in; maximum rating is likely to be about 15,000 lb, for a specific consumption of around 0.6 and a dry weight of well under 3,000 lb.

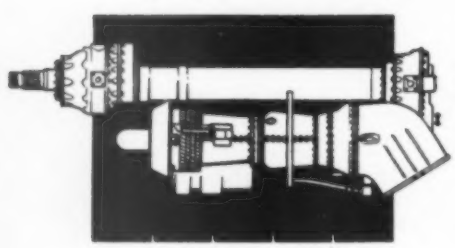


de Havilland Gyron Junior DGJ.10R Military single-shaft turbojet with reheat. Axial compressor (apparently with eight stages), annular combustion chamber with 13 upstream burners, turbine (apparently with two stages) and fully variable afterburner with con-di nozzle. Max overall diameter of engine, 32.3in; max diameter of afterburner, 36in; nozzle size, 27.8in (throat) and 32in orifice fully opened; overall length, 190.0in without intake bullet; all other data restricted, but the dry and reheat ratings at sea level are respectively 10,000 and 14,000 lb.



de Havilland Double Spectre Double-barrel rocket engine for supersonic applications. Two chambers, each fed with H.T.P. and kerosine by turbopumps, the lower chamber being infinitely controllable. Overall width, with mounting, 36.6in; height, 37.5in; length, 58.6in; combined sea-level thrust, 16,000 lb.

de Havilland Gnome P.1000 Company-sponsored turboprop. Ten-stage compressor with variable-incidence inlet guide vanes and first three stator rows, annular combustion chamber with 16 burners, two-stage compressor turbine, independent single-stage power turbine driving through rear reduction gear, high-speed top shaft and front reduction gear to suit propeller speeds from 1,245 to 1,550 r.p.m. Overall length as depicted, 87.3in; height, 31.55in; width, 17in; dry weight, with starter and accessories, 555 lb; mass flow, 12.4 lb/sec; pressure ratio, 8.3:1; max rating (5 min.), 1,000 s.h.p.+144 lb thrust at 26,260 r.p.m. (20,000 power-turbine r.p.m.) with s.f.c. of 0.669 lb/hr/s.h.p.; recommended cruise, 800 s.h.p. +120 lb at 25,120/17,000 r.p.m. with s.f.c. of 0.728; the later P.1200 will have corresponding ratings of 1,150 and 900 s.h.p. with s.f.c. of 0.657 and 0.71.



THE DE HAVILLAND ENGINE CO. LTD.

Leavesden Aerodrome, Herts. Telephone: Garston 4000

Double Spectre The basic Spectre rocket engine is a single-chamber unit, pump-fed with H.T.P. and kerosine. Extensively test flown beneath a Canberra and in the Saunders-Roe SR.53 experimental intercepters, most types of Spectre were rated at 8,000 lb sea-level thrust and could be throttled smoothly down to a small fraction of this value. Overall control and handling were of an exceptional order, and the engine may be regarded as the most highly developed rocket powerplant yet developed for manned aircraft.

Owing to changing operational requirements, the mixed-power intercepters which were to have used these engines did not materialize. Instead, the Double Spectre has been developed, and it can now be stated that the sea-level thrust of this unit is 16,000 lb and that it is the powerplant of the Avro Blue Steel air-to-surface missile. The complete package actually comprises two distinct Spectre units mounted one above the other, one chamber being a fixed-thrust rocket (presumably employed for boost propulsion) and the other being a fully controllable engine, the thrust of which can be programmed to suit the required mission profile.

Gnome The purchase last year of the licence to develop and market the General Electric T58 turboshaft engine was a bold commercial move which has already paid substantial dividends. Backed by 17,000 hr of running time, the T58 is now in full production at ratings slightly greater than 1,000 s.h.p., and it is flying in numerous American helicopters; advanced versions, rated at from 1,250 to around 2,000 s.h.p., are in various stages of development. The basic engine adheres to the precept laid down by G.E. several years ago, in which high pressure-ratio is achieved in a single spool by virtue of the employment of several stages of variable stators.

Initial development of the Anglicized engine—known as the Gnome—is now complete. Some half-dozen H.1000 helicopter Gnomes are running on the bench and this unit, equipped with a new D.H. Propellers fuel system, is in full production at Leavesden. One of these engines is flying in a Whirlwind, derated to about 780 s.h.p., and well over 100 may be required to re-engine Whirlwinds of the R.A.F. Further derated to 650 s.h.p., an H.1000 is also fitted to a Saro P.531 Mk 2, this installation involving a split tailpipe. A triple installation will be made in the big Agusta 101G helicopter and many other contracts are being discussed (some of which involve the fitting of Gnomes to exported American aircraft).

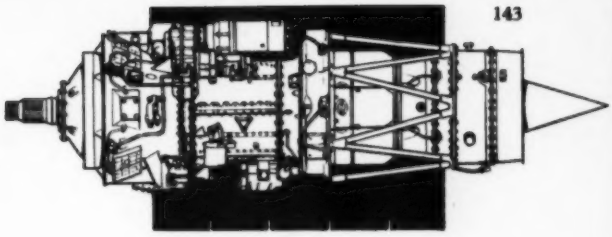
No fixed-wing variant of the G.E. engine exists, but D.H. are well advanced with the P.1000, the initial version of a complete engine-change unit for aeroplanes. To run during the coming winter, the turboprop will be certificated at 1,150 s.h.p. for the Bréguet 941 Intégral STOL and will doubtless also be fitted to the D.H.123. All Gnome development is company financed.

Gyron Junior As has often been the case with British turbojets, this engine has now materialized in two major development stages. The original PS.43, or DGJ.1 and 2, rated at 7,000 lb dry, is practically fully developed; it has been exhibited with a manifold for the provision of enormous quantities of bleed air, lending credence to the report that it is this version of the engine which powers the Blackburn NA.39. In this aircraft the Junior provides an excellent combination of low installed weight, high thrust, good specific consumption and excellent handling, and was instrumental in enabling Blackburn to beat their many competitors using different engines.

Now acknowledged as the powerplant of the soon-to-fly Bristol T.188 research aircraft, the advanced PS.50 or DGJ.10 has a zero-stage on the compressor, variable stators and numerous other refinements. Rated at 10,000 lb dry, it can be fitted with a fully variable afterburner to give a maximum reheat rating of 14,000 lb. Flight development of a pair of PS.50 engines with afterburners is shortly to begin, using a Javelin as test bed.

Ghost Production of new Ghost centrifugal turbojets has virtually ceased, although de Havilland continue to manufacture a large output of spares. The most recent mark in service is the 105, of 5,300 lb rating, which incorporates improved cooling arrangements; the many Ghosts in Sea Venoms of the Royal Navy are being brought up to 105 standard at Fleetlands.

Gipsy engines Limited production is continuing on the Major 10/2, Major 215 (with or without turbosupercharger as the powerplant of the latest Saro Skeeter helicopters), Queen 30 Mk 2 (Heron) and Queen 70 Mk 2 (Dove).



Napier Eland 504 Commercial single-shaft turboprop. Basic layout as for Eland 229. Diameter, 36in; length as depicted, 116in; dry weight, 1,820 lb; max rating, 3,230 s.h.p. (3,500 e.h.p.) at 12,500 r.p.m. with mass flow of 35.5 lb/sec, pressure ratio of 7:1 and s.f.c. of 0.57 lb/hr/e.h.p.; cruising rating at 20,000ft at 300 m.p.h., 1,635 s.h.p. (1,800 e.h.p.) at 11,750 r.p.m. The Eland 508 has a similar performance, although the max continuous rating is raised from 2,670 s.h.p. (2,910 e.h.p.) to 2,860 s.h.p. (3,110 e.h.p.).

D. NAPIER & SON LTD.

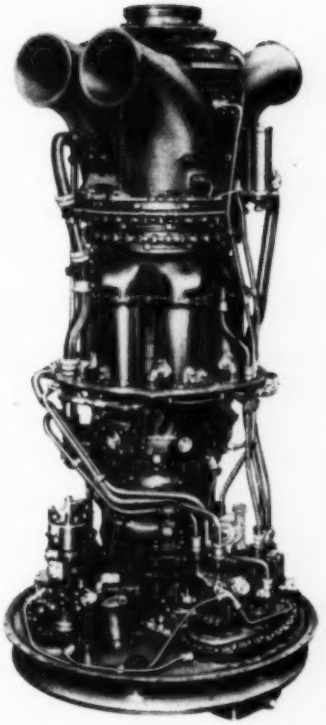
Acton, London, W.3. Telephone: Shepherds Bush 1220

Eland During the past year this single-shaft turboprop has been fully certificated by both the A.R.B. and C.A.A. for passenger-carrying service (it was the first turboprop in the world actually to be fully certificated under the new Anglo-American code), and is now in full production as the standard powerplant of the Canadair CL-66 and Convair-Canadair 540. Numerous conversion projects are also in hand, the best known involving CV-340 and CV-440 aircraft, one of the latter at present being in scheduled service with Allegheny Airlines. Total running time amounts to more than 20,000 hr, and the engine has demonstrated a high degree of reliability in arduous operational service.

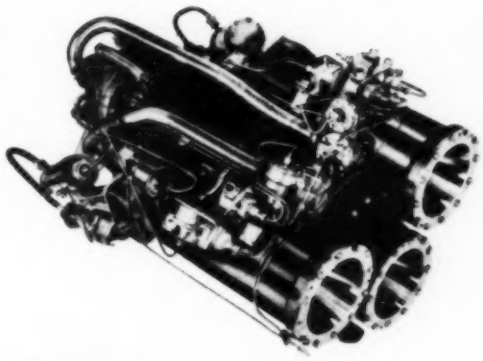
Extensive experience has been achieved by a special series of powerplants developed for the prototype Fairey Rotodyne, consisting essentially of a complete turboprop Eland to which has been added a rear drive, through a hydraulic clutch, to an auxiliary compressor which supplies fresh air to the pressure jets at the tips of the rotor blades. From this in turn has been evolved a new family of powerplants (E.211 and 229A) for the Westland Westminster helicopter. Since this aircraft has a hub-drive rotor, shaft-power is extracted from the rear of an adjacent pair of engines and taken by way of hydraulic couplings and a primary gearbox to the rotor itself. Matching and engine control have presented no major problems, and behaviour of the installation in flight has been exemplary. As the photograph shows, the main reduction gearbox and front drive have been removed; above the intake can be seen a large fan-assisted oil cooler.

Gazelle Now in full production for the Westland Wessex and Bristol 192 helicopters, the Gazelle is an any-attitude, free-turbine engine developed specifically for arduous service in helicopters. Air is taken in around a peripheral intake upon which are mounted numerous accessories; points of note include the can-annular combustion system, flexible mounting of the primary reduction gear and the division of the exhaust trunk into four. According to the handing of the turbine rotor blades the output shaft may have left- or right-hand rotation, and in twin-engine installations the Gazelle's control system automatically compensates for loss of either engine by increasing the power of the other up to 30 per cent above the one-hour rating.

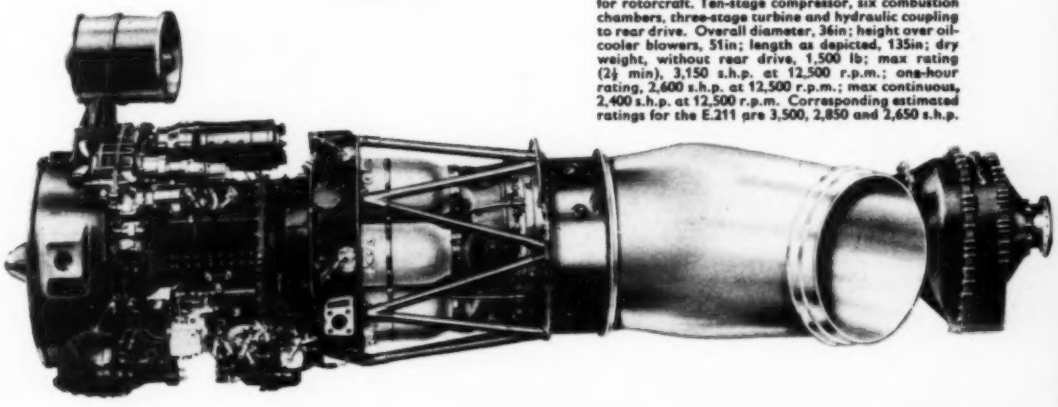
Scorpion Designed and developed at the company's Flight Development Establishment at Luton, this family of rocket engines includes units with one, two or three thrust chambers, all operating on pump-fed H.T.P. and kerosine. Of exceptionally compact configuration, the Scorpion packages are highly developed; numerous applications—involving such vehicles as F-86 Sabres and supersonic targets—are under discussion.



Napier Gazelle NGa.13 Military free-turbine turboshaft engine. Eleven-stage compressor, six combustion chambers, two-stage compressor turbine and single-stage free power turbine. Overall diameter (intake casting), 33.5in; overall height, 70in; equipped dry weight, 865 lb; max rating 1,900 s.h.p. (5-min limit) at 20,400 compressor r.p.m. with s.f.c. of 0.664, or 1,450 s.h.p. (one-hour) at 19,500 compressor r.p.m. with s.f.c. of 0.703. Note: this engine can be mounted at any angle and is shown in the vertical position.



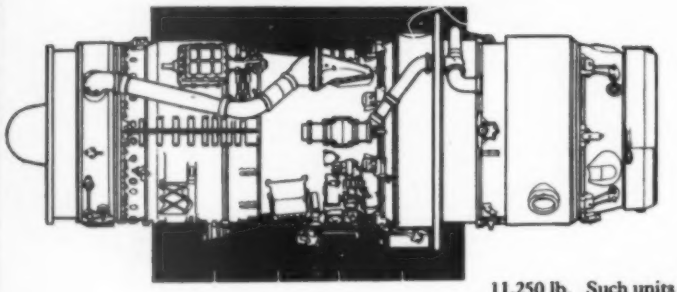
Napier Triple Scorpion Aircraft or missile rocket engine with three individually controlled chambers each fed by turbopump with H.T.P. and kerosine. Overall width of unit, 21.5in; overall height, 17.75in; length, 35in; further details may not be disclosed, although the sea-level rating of the single-chamber Scorpion NSc.1 is 2,000 lb.



Napier Eland 229A Commercial turboshaft engine for rotorcraft. Ten-stage compressor, six combustion chambers, three-stage turbine and hydraulic coupling to rear drive. Overall diameter, 36in; height over oil-cooler blowers, 51in; length as depicted, 135in; dry weight, without rear drive, 1,500 lb; max rating (2½ min), 3,150 s.h.p. at 12,500 r.p.m.; one-hour rating, 2,600 s.h.p. at 12,500 r.p.m.; max continuous, 2,400 s.h.p. at 12,500 r.p.m. Corresponding estimated ratings for the E.211 are 3,500, 2,850 and 2,650 s.h.p.

ROLLS-ROYCE LTD.

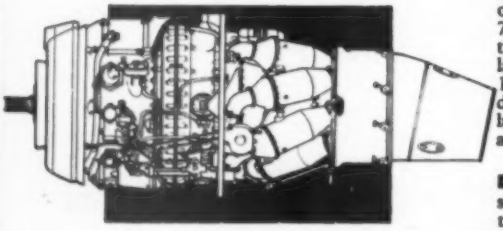
Nightingale Road, Derby. Telephone: Derby 42424



Rolls-Royce Avon RA.29 Mk 527 Commercial single-shaft turbojet. Sixteen-stage compressor, annular combustion chamber with eight flame tubes, three-stage turbine and two-position sound-suppressing nozzle. Installational envelope diameter, 39in; diameter outside intake, 35.7in; overall envelope diameter, 43in; length as depicted, room temp., 125.975in; dry weight, 3,327 lb (including oil and fuel systems, controls and electrics); max sea-level rating, with nozzle in closed position, 11,700 lb at 8,000 r.p.m.; corresponding mass flow and pressure ratio, 173 lb/sec and 9.63:1; max continuous rating, 9,810 lb with s.f.c. of 0.749; low-percentage cruise rating at M 0.74 at 35,000ft, standard day, with nozzle open, 1,820 lb at 6,850 r.p.m. with s.f.c. of 0.885.

Avon The first axial gas turbine to enter British service, the Avon has been produced in several factories in England and Scotland since 1950 and has also been made in large numbers in Belgium, Sweden and Australia. Several thousand of the first-generation 100 series of Avons are in service with such aircraft as the Hunter, Swift, Canberra, Lansen and Comet C.2. In 1954 the more advanced 200 series of Avons became available, their higher pressure ratio and increased mass flow raising the dry thrust to some 10,000 lb; and current engines of this class have air-cooled turbine blading, permitting exceedingly high top temperatures and ratings of at least 11,250 lb. Such units have been built in quantity for the Hunter and Valiant, and remain in production for the Sea Vixen, Scimitar, Canberra PR.9 and, with afterburner, for the Lightning, J32B Lansen and Draken.

For commercial purposes a substantially redesigned series of powerplants has been evolved, distinguished by a zero-stage on the compressor (conferring increased mass flow and pressure ratio) and a third stage on the turbine. Grouped under the family classification of RA.29 these powerplants entered service with the Comet 4 last year at a dry rating of 10,500 lb and with the unprecedented initial overhaul life of 1,000 hr. Experience with B.O.A.C. has permitted overhaul life to be increased to 1,300 hr, and trial engines are running up to 1,600; and reliability is underlined by the fact that the unscheduled-overhaul rate is at present one in 49,000 flight hours. Many of these Avons are now in service with Comets and Caravelles, and more advanced engines, at present culminating in the RA.29/6, are being planned to give thrusts up to over 12,500 lb, with exceedingly competitive fuel consumption. Alternatively, operators may elect to re-engine Comets or Caravelles with engines of later basic design, such as the RB.141 or RB.163 described on p. 145.



Rolls-Royce Dart RDa.7/2 Mk 526-530 Commercial single-shaft turboprop. Two centrifugal compressors in series, seven canted combustion chambers and three-stage turbine. Overall diameter at rear of nose cowl, 33in; max diameter across firewall, 37.9in; length as depicted, 97.64in; dry weight, 1,250 lb fully equipped; max sea-level rating, usually 1,910 s.h.p. (2,100 e.h.p.) at 15,000 r.p.m. with s.f.c. of 0.66 lb/hr/s.h.p.; corresponding mass flow and pressure ratio, 22 lb/sec and 5.62:1.

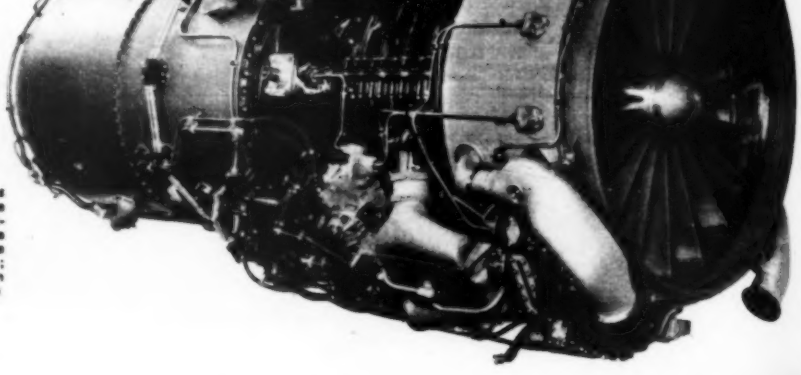
Dart RDa.10 Similar configuration. Slightly longer; dry weight 1,323 lb; max sea-level rating 2,440 s.h.p. (2,660 e.h.p.) at 15,000 r.p.m., with s.f.c. of 0.64 lb/hr/e.h.p. and mass flow and pressure ratio of 25.5 lb/sec and 6.35:1.

Conway The world's first large engine incorporating the double-flow principle—characteristic of by-pass turbojets and ducted-fan engines—the Conway started as a 9,250 lb engine in 1950 and is today in full production for military and civil aircraft at ratings of 17,250 and 17,500 lb respectively. The example illustrated is the powerplant of the Victor B.2 bomber. Commercial Conways include the Mk 505 for the Boeing 707-420, the Mk 507 for the DC-8 and a more advanced unit for the VC.10. Originally the commercial Conway was scheduled to enter service late this year at 16,500 lb, but last month Rolls-Royce announced that, owing to very satisfactory development, the 17,500 lb rating—achieved merely by recalibrating the fuel control—will now be introduced at the outset, some 18 months earlier than promised. Minor modification will later permit the same powerplants to be cleared at 18,500 lb, and it seems evident that a 20,000 lb-thrust Conway is not far distant.

Dart In production since 1952 for Viscounts, and in scheduled service in this aircraft since the spring of 1953, the Dart is today the most experienced and reliable airline gas turbine in the world. Total flight time is in excess of 8,000,000 hr, and the established overhaul life of 2,300 hr for early versions surpasses that of virtually every piston engine. The principal marks currently in service are the Dart 506 (1,400 s.h.p.), the Mk 510 series (1,600 s.h.p.) and the Mk 520 family, which normally have ratings of from 1,800 to over 1,900 s.h.p. Production is now concentrated largely upon the latter units, the principal applications involving the Viscount 810, Herald, Friendship, Argosy, Gulfstream and Bréguet Alizé. Soon to come is the Dart 540, in which numerous refinements will permit a rating of up to 2,500 s.h.p. to be achieved; these engines have already run many hours on the bench and a military wet rating of 3,200 s.h.p. was established early last year.

RB.108 One of the first of a family of small turbojets of very high thrust/weight ratio, the 108 is employed for both vertical lift and forward propulsion. Five are fitted to the Short SC.1 VTOL research aircraft, the rating being 2,010 lb.

RB.140 One of the large family of related engines of high by-pass ratio intended for commercial transport applications, the RB.140 is rated at some 8,000 lb thrust and would be suitable for four-engined aircraft of around 100,000 lb gross weight. It was recently suggested that Rolls-Royce had requested M.o.S. financial assistance on this project.



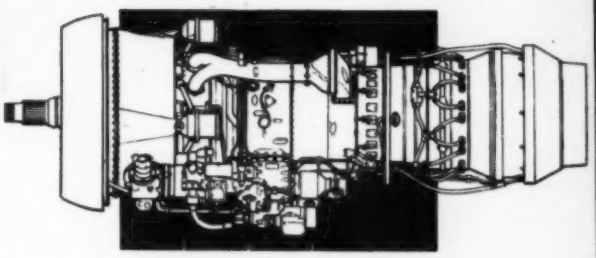
Rolls-Royce Conway RCo.11 Military by-pass turbojet (for Victor B.2). Multi-stage, low-pressure (fan) compressor, multi-stage, high-pressure compressor, annular combustion chamber with ten flame tubes and independent high- and low-pressure turbines. Diameter across outside of intake, 37.6in; overall installational envelope diameter, less than 47.5in; length from nose bullet to turbine exit cone 144.21in; sea-level rated dry thrust, 17,250 lb.

RB.141 Now in a very advanced state of development and about to start bench tests, the 141 is specifically planned to be the optimum engine for subsonic transport propulsion. In it are incorporated all the lessons learned with by-pass engines (Conway), units of very high pressure-ratio (Tyne) and turbojets with extremely high top temperature and air-cooled turbine blades (military Avon). Ratings for the 141 will lie between 12,000 and 16,000 lb; initial deliveries will probably be made at some 14,300 lb for an advanced version of the Caravelle.

RB.145 Essentially a long-life turbojet for aircraft, largely based on the RB.108, the 145 would be rated at 2,750 lb thrust and would have a very high power to weight ratio. It remains a project only.

RB.163 The existence of this very advanced by-pass turbojet for commercial transport applications was revealed when the specification for the redesigned D.H.121 airliner was published late last month. Rated initially at 10,100 lb, the RB.163 will have an exceedingly low specific fuel consumption and will be installed in a triple arrangement in the rear of the 121 fuselage, each engine having a thrust reverser and quiet-running nozzle.

Owing to the fact that it is at present in a relatively early state of development Rolls-Royce are naturally reticent regarding the engineering design of the RB.163 and it is too early to publish even a brief specification. Nevertheless, one may expect this powerplant to have an exceedingly high inbuilt pressure-ratio—possibly at least as high as the 13:1 of the Tyne turboprop—together with a by-pass ratio not less than unity and a turbine temperature very much higher than that of the commercial Avons (air-cooled blades are a certainty). Undoubtedly the 163 will weigh less than 2,500 lb and one may expect its qualities to be such as to carve out a wide commercial market.

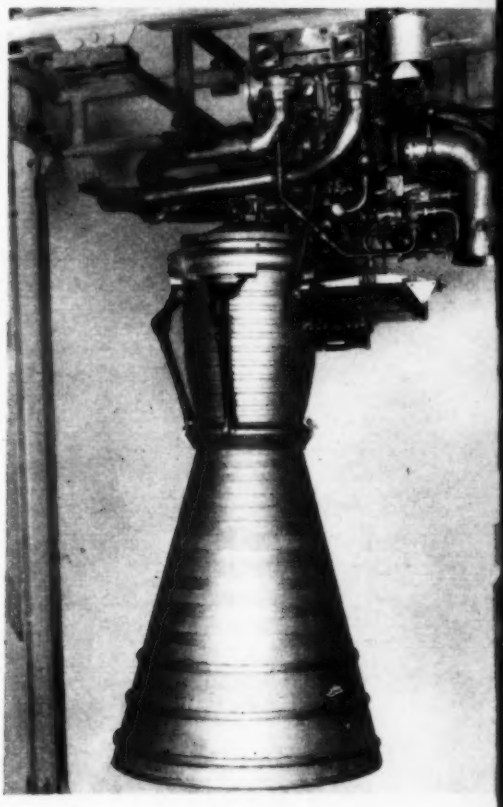


Rolls-Royce Tyne RTy.1 Mk 506 Commercial two-spool turboprop. Six-stage low-pressure compressor, nine-stage high-pressure compressor, annular combustion chamber with ten flame tubes, single-stage high-pressure turbine and three-stage low-pressure turbine. External diameter over intake, 35.3in; overall installational envelope diameter, 40.5in; length as depicted, room temp., 110.154in; dry weight, 2,220 lb with all equipment; max sea-level rating, 4,500 s.h.p. (4,985 e.h.p.) at 15,250 r.p.m.; corresponding mass flow and pressure ratio, 46 lb/sec and 13:1; typical cruising rating, 425 m.p.h. at 25,000ft, standard day, 2,455 s.h.p. (2,685 e.h.p.) with s.f.c. of 0.405 lb/hr/e.h.p. Ratings of later Tynes are given in Col. 1.

Rocket Engines Since 1955 Rolls-Royce have held a licence to develop and manufacture large liquid-propellant rocket engines for ballistic vehicles, incorporating design information from the Rocketdyne Division of North American Aviation. One of the first of these units to be produced is illustrated on this page; and a twin-engine installation powers the first stage of the D.H. Propellers Blue Streak LRBM. No engineering information on these units may be disclosed, but it is logical to assume that they will have a sea-level thrust of at least 150,000 lb and will operate on liquid oxygen and a hydrocarbon fuel. Test firings will shortly commence at the Spadeadam site in Cumberland, which is managed by Rolls-Royce on behalf of the M.o.S.

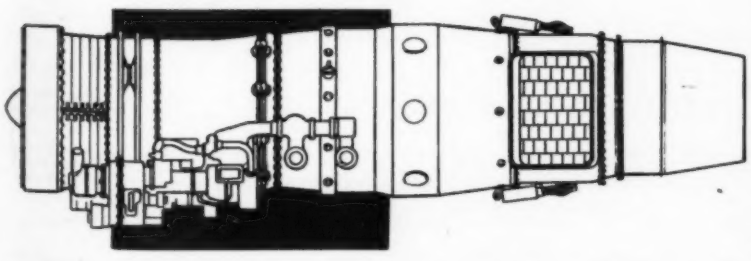
As the photograph at lower right indicates, the Rolls-Royce engines appear to have a gimbal-mounted chamber fabricated from an assemblage of nickel tubes, disposed axially and brazed together, the considerable bursting strength of the chamber (especially in the high-pressure zone in the region of the throat) being achieved by welding-on circumferential rings. Compared with the Rocketdyne engines used in production IRBMs and ICBMs the British unit has straight taper over the divergent nozzle, a profile which can also be seen in the drawing of Blue Streak published on p. 148. The latter illustration also depicts the downward-pointing exhaust stacks from the turbopump gas-generator of each chamber; the overboard pipe from the generator can also be seen on the right-hand side of the earlier development engine illustrated on this page.

Rolls-Royce LRBM Engine The photograph below is the only illustration to have been released for publication showing a large Rolls-Royce rocket engine constructed under the terms of the company's licence agreement with Rocketdyne. It can be seen to incorporate the American basket-tube form of chamber, approximating more nearly to a true cone than do those of the corresponding Rocketdyne engines (such as the S-3 and ME-3). The turbopump and control system is likely to be pure Rolls-Royce. The production engine for the Blue Streak LRBM may be expected to resemble this unit in broad outline only.



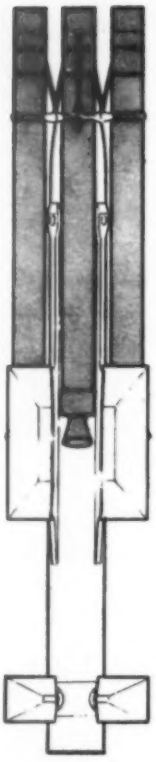
Tyne Although originally projected as an engine in the 2,500 h.p. class, the Tyne is today in production at double this power and has been chosen for the Vanguard, CL-44, Britannic, Bréguet 1150, Transall C.160 and for projected versions of the Argosy. Its two-spool compressor operates at high r.p.m. and achieves a very high pressure-ratio; and this, coupled with air-cooled turbine blading, has permitted the specific fuel consumption to be brought down to levels similar to those of the most efficient piston engine. Flight development has been conducted with engines mounted in a Lincoln and an Elizabethan, and time is now building up rapidly, with several Vanguards already in the air. All Tyne installations at present projected incorporate a de Havilland four-blade propeller provided with β-control.

First airline service is scheduled with B.E.A. for March 1960. These initial V.951 Vanguards will be fitted with the RTy.1 Mk 506 rated at 4,500 s.h.p. (4,985 e.h.p.). Succeeding Vanguards will have the second production engine, at the RTy.11 rating of 5,030 s.h.p. (5,525 e.h.p.). These Tynes incorporate several design improvements, including rematching to an even higher turbine entry temperature made possible by improved blade materials, and achieve a cruising s.f.c. of 0.388 lb/hr/e.h.p. For the Canadair CL-44 the RTy.12 has a larger final nozzle in order to provide increased shaft-power at take-off, the propeller size being correspondingly increased. The RTy.12 has a military dry rating of 5,300 s.h.p. (5,730 e.h.p.) and is likely to enter service with the R.C.A.F. in the summer of next year. An essentially similar engine will be fitted to the Short SC.5 Britannic 3 for the R.A.F. and is also specified for NATO transport and maritime-patrol aircraft and for the twin-engined AW.651/661/671.



Rolls-Royce RB.141 Commercial high-ratio by-pass turbojet. No details have been released, except for the fact that the thrust of the first series will lie between 12,000 and 16,000 lb, according to application; first deliveries are likely to be rated at 14,300 lb. The five-foot scale in the drawing is approximate.

British Missiles 1959



SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

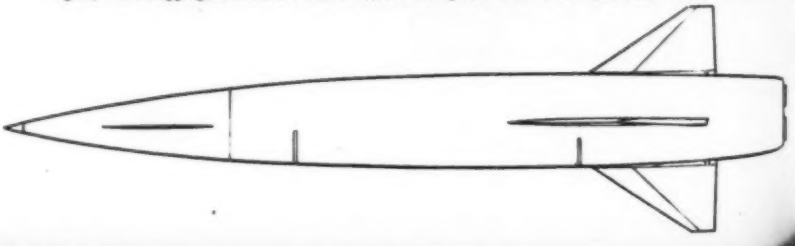
Whitley, Coventry. Telephone: Tollbar 3271

Seaslug Chosen by the Royal Navy as the standard ship-to-air guided weapon for installation on larger ships, Seaslug has been planned to achieve maximum accuracy and lethality within an overall package of minimum size; and it forms part of an integrated weapon system which includes storage magazines, powered handling equipment, automatic check-out facilities and an automatically stabilized launcher. Development of the complete system has been managed jointly by Armstrong Whitworth, the General Electric Company and Sperry Gyroscope Company, who have respectively been responsible for the missile itself, the guidance system and the control system. It can now be stated that Seaslug is a beam-rider. Powerful shipborne radar illuminates the target in a locked-on pencil beam; the Seaslug flies up the centre of the beam, the guidance system containing circuits which immediately detect any departure of the flight path from the beam's axis.

Firing trials have been taking place from shore establishments, from the Clausen Rolling Platform and from H.M.S. *Girdle Ness*. The latter has been conducting firings both in the Mediterranean and in home waters, and results have been most successful; according to Armstrong Whitworth "when a salvo of two Seaslugs was fired . . . the first missile hit the target aircraft and the second veered off and hit the largest piece of the remaining wreckage." The first ships to be armed with the Seaslug system will be large County-class ships, the first of which—H.M.S. *Hampshire*—has been under construction for some months.

Armstrong Whitworth Seaslug (photograph above, drawing left) Four wrap-round boost motors, internal sustainer. Length, about 20ft, body diameter, about 16in; wing span, about 63in; control-surface span, about 63in.

Avro Blue Steel Vehicle basically of aeroplane configuration, with canard foreplane, rear-mounted mid wing and fixed upper and folding lower fins. The powerplant of this weapon is a de Havilland Double Spectre rocket engine, with an aggregate sea-level thrust of 16,000 lb. Length, at least 35ft; wing span, probably less than 20ft.



A. V. ROE & CO. LTD. (Weapons Research Division)

Woodford, Cheshire. Telephone: Bramhall 1620

Blue Steel As the armaments division of one of our largest aircraft companies, the team at Woodford are well equipped to tackle projects of the first magnitude, and for at least two years their prime task has been the complete responsibility for the Blue Steel air-to-surface missile—or "stand-off bomb"—for the latest V-bombers of the R.A.F. Such a weapon is virtually a pilotless aeroplane with a self-contained guidance system which, as a result of its small size and exceedingly high performance, should prove far more difficult to intercept than would its parent aircraft. As a result the latter can "stand-off" from its target by a distance of several hundred miles, the Blue Steel transporting the desired payload (presumably a thermonuclear device) along a complex mission profile and placing it precisely on the desired target.

Although the external configuration of Blue Steel is well known (the side elevation at the foot of the opposite page is the most accurate yet to have been published) very little design information on this weapon has yet become available. The finely streamlined fuselage, some 35ft in length, houses a guidance system, the payload and large tanks for H.T.P. and kerosine which feed the de Havilland Double Spectre rocket engine mounted at the rear. Aerodynamically the vehicle has a canard configuration, lift being provided by a rear-mounted delta wing, provided with small inboard ailerons, and control being exercised by the ailerons operating in conjunction with a delta foreplane and upper and lower fixed fins. In order to provide adequate ground clearance the lower fin is arranged to fold to port until shortly before launching; and, in order that the wing tips shall not foul the jet pipes of the Victor B.2 (which, with the Vulcan B.2, will carry the weapon in service), the latter are tilted acutely downwards. Blue Steels are at present engaged in firing trials at Woomera.

BRISTOL AIRCRAFT LTD.

Filton, Bristol. Telephone: Filton 3831

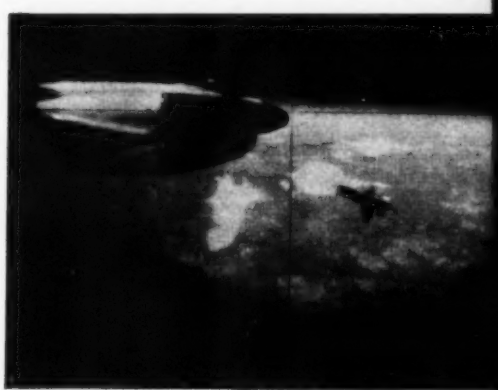
Bloodhound During the past year this surface-to-air weapon system has become the first to enter British service. Developed by "the largest missile work-force in Europe," led by Bristol Aircraft, Bristol Siddeley Engines and Ferranti, Bloodhound is today in full production and is operationally deployed at stations of R.A.F. Fighter Command. Moreover, Bloodhound has also achieved the first export sale of a British guided weapon, a contract having been placed by the Royal Swedish Air Board after an evaluation of all competing systems. The Ministry of Supply have loaned a complete missile and its ground-support equipment to the Swedes to enable them to become familiar with the system.

In many respects the missile itself is unique. Aerodynamically it is both lifted and steered by a pair of sharply tapered wings, which can be moved together to act as elevators or differentially to act as ailerons. They operate in conjunction with a fixed tailplane, and directional stability is enhanced by the large side area of the twin Bristol Siddeley Thor ramjet engines used for cruise propulsion. Mounted above and below the fuselage, these engines burn kerosine and confer a range described as "longer than that of any [other] semi-active homing missile in the free world."

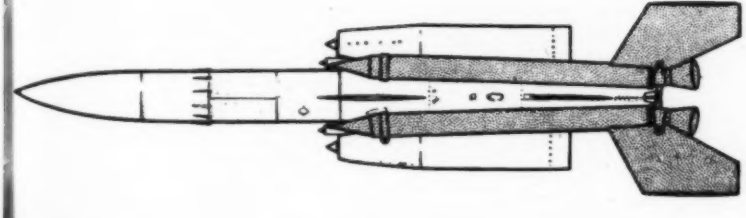
Semi-active homing guidance involves illumination of the target by a powerful "lamp" set on the ground, and a receiver aerial in the missile which can pick up the radiation reflected from the target. B.T.H. supply the "Sting Ray" lamp set, and a complete Bloodhound system also incorporates a powerful tactical control radar supplied by Metropolitan-Vickers. Each radar serves a large number of launchers and models have indicated that 16 Bloodhounds in four rows each of four launchers might equip a typical station. As far as possible the complete system has been designed to be integrated into the existing United Kingdom defence environment, and is flexible enough to provide perimeter defence of a limited area or "barrier" defence of a large land-mass.

In order to minimize structural weight magnesium-alloy castings have been widely employed, cored or machined where necessary in order to accommodate electric cables and hydraulic piping. Stiff longerons run along the top and bottom of the missile body, tension bolts being used at the joints between the forebody and mainbody. Remaining primary structure is largely of conventional aluminium alloy, which is satisfactory for the temperatures and flight-times involved. The most robust member of the airframe is the mainframe casting, which carries the forward mountings for the upper and lower engines and the hubs for the two wings. The latter surfaces consist of a wooden matrix to which is bolted front and rear root ribs, a light-alloy mounting spigot, a magnesium-alloy leading edge and flush-riveted light-alloy skins; similar construction is employed for the tailplane.

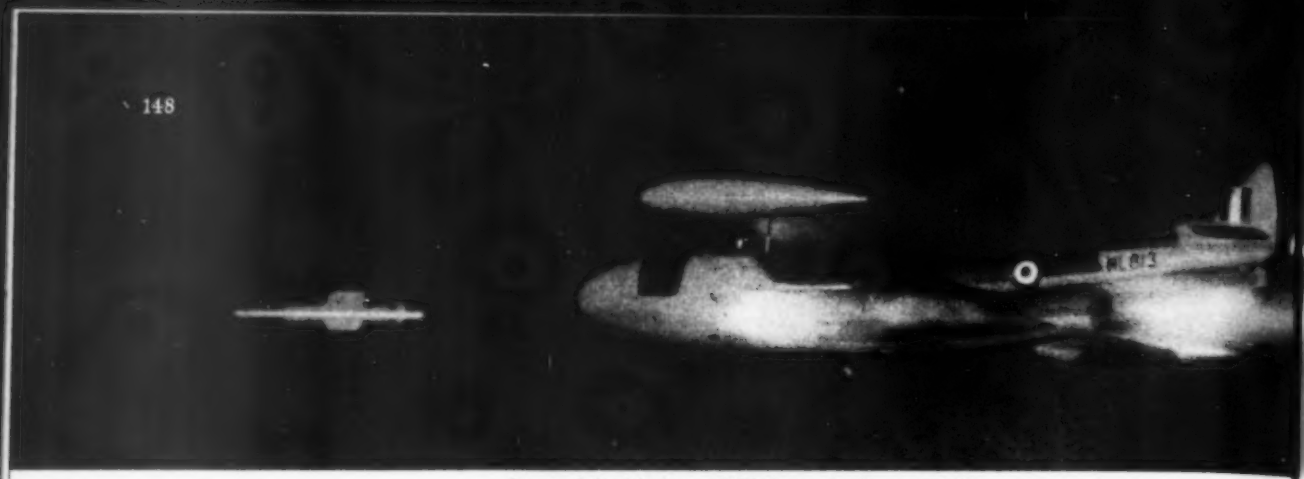
Most surface-to-air guided weapon systems are extensive and complex, the missile merely being a very important cog in an overall machine which embraces a control and reporting organization, early-warning and target-illuminating radars, ground-handling gear and launchers. It is therefore desirable to improve the system step-by-step, and the advanced version of Bloodhound recently stated to be under development for the R.A.F. will fit into the existing system. This has the added great advantage of not requiring any extensive re-training or conversion course for the large numbers of personnel involved. The advanced missile will have much greater performance than the Mk 1 Bloodhound, and will have greatly improved lethality against targets right down to ground level. Flight trials are in hand at Woomera.



Above are frames from cine-cameras carried by targets engaged by Bloodhounds during development trials. The targets in the two lower pictures were radio-controlled Meteors

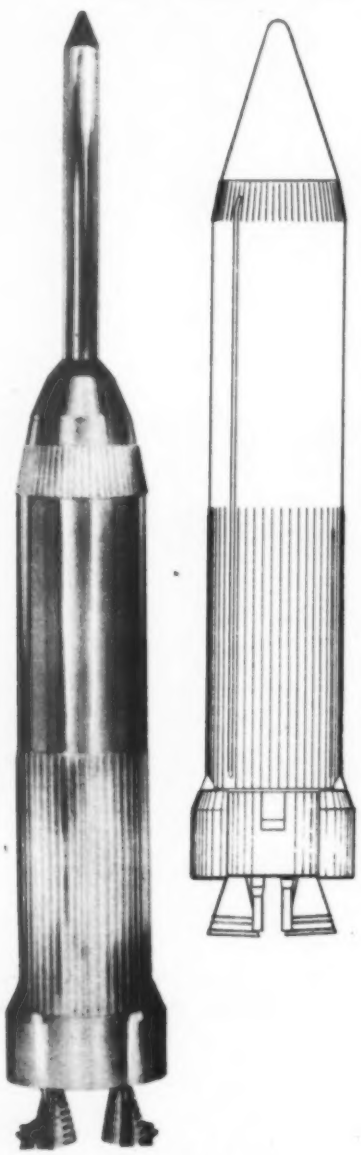


Bristol Bloodhound (Red Duster) Four wrap-round solid boost motors, two Bristol Thor ramjet sustainers. Overall length, 25ft 3in; body length, 22ft 2in; wing span, 9ft 3in; body diameter, 21in.



Firestreak fired by Venom NF.2 during development trials

de Havilland Propellers Blue Streak On the left is depicted a Blue Streak acting as first stage to a Black Knight in a space project. On the right is an official representation of the operational weapon. Approximate data for the latter are: height, 70ft 6in (76ft with motor chambers); body diameter, 11ft 8in (15ft across skirt blisters); firing weight, probably about 175,000 lb; sea-level thrust of first stage, at least 300,000 lb; design ultimate range, about 2,500n.m.



DE HAVILLAND PROPELLERS LTD.

Hatfield, Herts. Telephone: Hatfield 2300

Blue Streak Although its design is now at a very advanced stage, and a vast amount of "hardware" has been manufactured, Britain's long-range ballistic missile remains very closely shrouded by security, and no specific design information may be published. Much can, however, be gleaned from a study of the little that has become available, and much more may be surmised by arguing from basic principles. The only official clue to the configuration of the complete weapon is provided by the photograph (reproduced at far left) of a Blue Streak used as the first stage of a space-research vehicle (the second stage being a Black Knight). Alongside appears a drawing of Blue Streak taken from a paper published last week by de Havilland Propellers Ltd. The original drawing terminated at the transition ring and the profile of the nose-cone is, therefore, unofficial. It is pertinent to comment that the complete airframe can be inspected at leisure in test towers at Hatfield.

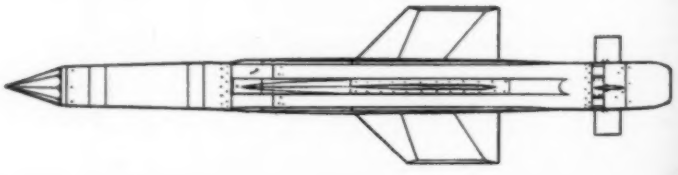
It has been suggested unofficially that Blue Streak is designed for a range of around 2,500 n.m. (2,879 st. miles). This is almost double that of the American IRBMs; yet, since the British missile is a much more recent design, the increased range—and doubtless warhead yield per unit of warhead weight—is not matched by a corresponding increase in airframe size or firing weight. It appears that Blue Streak will be at least 75ft high, and its airframe—by D. H. Aircraft—appears to be manufactured from exceedingly thin stainless-steel, stiffened by axial corrugations. The main tankage sections seem to have a total capacity for propellants of the order of 23,000 gal. Doubtless liquid oxygen and hydrocarbon fuel (similar to American RP-1) are employed, and these fluids are fed down by turbopumps to the gimbal-mounted chambers of the two Rolls-Royce rocket engines which can be seen projecting from the skirt at the base of the body. No clue has yet been given to the location of the vernier motors, and it may be that D.H. Propellers have been clever enough to dispense with such devices.

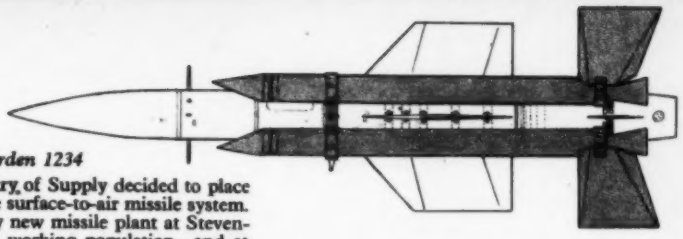
Above the liquid-oxygen tank the airframe is progressively reduced in diameter, and finally meets the warhead and nose-cone on a transition ring. Cones worn by Black Knight seem to have had an included angle of some 40 deg, and it is worth noting that a 5ft 4in band around the forward end of the body has closely spaced axial corrugations. Behind this region one may expect to find airborne elements of the guidance system, the prime contractor for which is the Sperry Gyroscope Co.

It was in August 1957 that the Minister of Defence announced the existence of the Blue Streak project. At the same time the prime contractor issued a statement in which the weapon was described as being designed "to carry a thermonuclear warhead with extreme accuracy over a range of several thousand miles. . . ." The Propeller Company have concentrated Blue Streak design and development at Hatfield and at a large design office in London; extensive rig-testing is in hand at Hatfield, static firing of the Rolls-Royce engines is about to begin at a Ministry of Supply establishment at Spadeadam Waste in Cumberland, and firing trials of the complete missile will take place on the extended range at Woomera, probably before 1961. From the outset it has been suggested that the operational LRBM would be housed in hard pads, i.e. underground pits which protect the missile from the effects of nuclear explosions. It may be assumed that the user service will be the Royal Air Force.

Firestreak As the standard air-to-air missile of the R.A.F. and Royal Navy, Firestreak is now fully developed in its initial operational form and is in service with Fleet Air Arm Sea Vixen squadrons. Release to Fighter Command squadrons equipped with Javelins (and to Lightning squadrons as they are formed) should not be long delayed. Many hundred of rounds have been fired both in the United Kingdom and in Australia, from such aircraft as the Hunter, Avon-Sabre, Canberra, Venom and Sea Venom, and an exceptionally high lethality has been established. Infra-red homing guidance is employed, the seeker cell being housed beneath the octagonal nose and additional elements of the guidance system being located behind rings surrounding the forebody. A successor to Firestreak is under development.

de Havilland Propellers Firestreak (Blue Jay) Solid sustainer motor. Length, 10ft 5.28in; body diameter, 8.67in; span of wings, 29.4in; span of controls, 19.1in. Weight and performance data restricted.





English Electric Thunderbird Mk 1 (Red Shoes) Four wrap-round boost motors, solid sustainer motor. Length (with or without boosts), 21ft; body diameter, 21in; span of wings, 63in; span of control fins, 63in. Weight and performance data restricted.

ENGLISH ELECTRIC AVIATION

Marconi House, London, W.C.2. Telephone: Covent Garden 1234

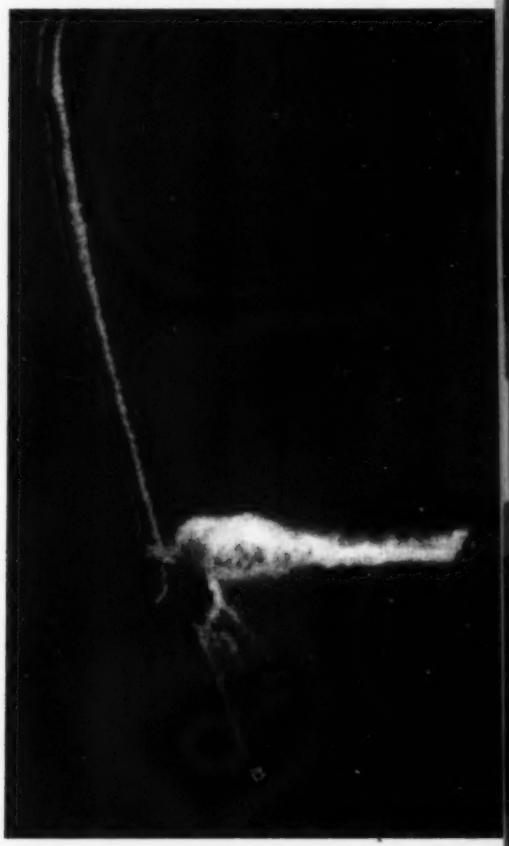
Thunderbird It was in October 1948 that the Ministry of Supply decided to place a major contract with English Electric involving a complete surface-to-air missile system. Since that time the company have established a completely new missile plant at Stevenage—which today employs about one-third of the town's working population—and at Luton, where the Thunderbird missile system is today in production for the British Army. Early development was concentrated upon test vehicles powered by an internal liquid-propellant motor; later a solid sustainer was adopted and in recent years the entire airframe has been re-engineered in order to fit it for bulk production and arduous operational service, including an overall policy of "maintenance by replacement" wherever practicable.

The basic airframe consists of a circular-section body consisting of sections clipped together by manacle rings, the nose being a large pointed radome. Guidance is of the semi-active homing variety, the ground equipment including a tactical control radar, where incoming raids are resolved into individual targets and allocated to weapon sites where each target is acquired by a tracking and illuminating radar. Each of the latter radars feeds a number of associated launcher/missile combinations. The entire system is designed to be transportable at normal road speeds, and the launchers can be deployed in fixed installations or on wheeled chassis.

Rounds are dispatched in either of two conditions. In the first instance the complete missile is delivered as a series of packaged sub-assemblies, each of which can be removed from its environment-free and shock-proof transit container and built into a missile in a matter of minutes. Alternatively the body may be received in "cigar" form, requiring only functional testing and the addition of wings, fins, warhead, radome and the four wrap-round boost motors. The complete round is then placed on the launcher elevating frame which is a steel-tube structure with a fixed elevation of 50 deg, carrying the missile by zero-length feet on the lower pair of boost motors. The complete elevating frame is then taken on a special trailer to the launching base, on to which it is moved by a rail system and secured by a pair of rotary locking shafts. All missile services are fed in through a fly-off head which provides multi-pin electrical and pneumatic connections through sockets at the base of the body. It is anticipated that Thunderbirds should be capable of being left on launchers in any climate for up to two years. Very extensive firing trials have taken place at Aberporth and Woomera, and on June 5 last *Flight* reported a visit to the Army's Thunderbird training school at Manorbier.

It was recently announced that a Mk 2 version of Thunderbird is in the course of development, claimed to offer substantial advances in range and overall lethality and to be better suited to engaging targets at all altitudes. It has frequently happened in the past that missiles with semi-active homing guidance have been limited electronically in that the effective range of the radars has been less than the practicable range of the missile up to the point at which the flight speed becomes too low for control to be maintained. Although all details are obviously classified it seems fair to assume that the electronic performance of Thunderbird Mk 2 must be considerably better than that of the Mk 1 system.

Destruction of jet target by a Thunderbird



FAIREY AVIATION LTD. (Weapon Division)

Heston, Middx. Telephone: Hayes 2821

Anti-Tank Missile Not yet officially named, this missile is under development against a Ministry of Supply contract for the British Army. It has been stated that, when fully developed, it should "sweep the heavy tank from the battlefield."

Fireflash For more than two years No. 1 Guided Weapon Development Squadron have been operating Swift F.7 aircraft from Valley on indoctrination missions with these air-to-air missiles. Not released for operational service, Fireflash—originally code-named Blue Sky—is a beam-rider and consists of an unpowered Dart boosted to supersonic speed by jettisoned motors. This form of propulsion was adopted in order to eliminate the possibility of introducing guidance errors as a result of ionization of the radio beam by the flame from the motor. In the photograph below a round can be seen immediately after launching; both motors are firing and the weapon has yet to be gathered into the beam transmitted from the nose of the parent aircraft.

Launch of a Fireflash from a Swift F.7 fighter

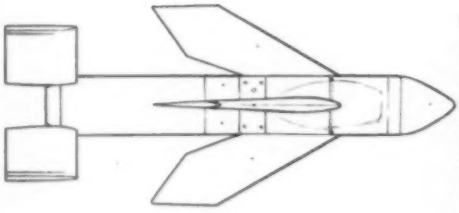
Pye PV missile

Seacat leaving launcher at a shallow angle

PYE LTD.

Royston, Cambs. Telephone: Royston 3072

PV During the past year this private-venture missile project has "progressed according to schedule" and test firings have taken place on the Government range at Larkhill, Wilts. A wire-guided anti-tank missile, the Pye weighs 80 lb and the company's great experience in the field of miniature electronic systems is in this project allied with an advanced airframe and a solid motor by Bristol-Aerojet.



Short Seacat Internal solid-propellant motor, presumably with boost and cruise levels of thrust. Length, 57.85in; wing span, 25.6in; body diameter, 7.5in.

SHORT BROS. & HARLAND LTD.

Queen's Island, Belfast. Telephone: Belfast 58444

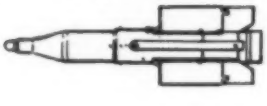
Seacat At the 1958 S.B.A.C. show Short Bros. exhibited a diminutive test vehicle designated SX-A5, with the caption that it was designed for research into surface-to-air problems. From it has been evolved a complete system intended for short range ship-to-air, surface-to-air and surface-to-surface operations. A Ministry of Supply development contract has been placed for the ship-to-air version, which is popularly known as Seacat (the land-based variant is named Tigercat), and it has been stated that this missile will replace the 40 mm guns at present used on practically all combat ships of the Royal Navy for anti-aircraft purposes. The basic weapon has a stubby body—suggesting a relatively modest performance—with a cross-section which becomes square in line with the cruciform of moving wings. The weapon is fired by a solid-propellant motor from a high-angle launcher of very simple design which can be accommodated on deck or on a vehicle. The complete system, which may well involve radar command guidance, is designed for instant readiness and appears to be one of extraordinary versatility and unique attraction to a large number of overseas customers.

VICKERS-ARMSTRONGS (AIRCRAFT) LTD.

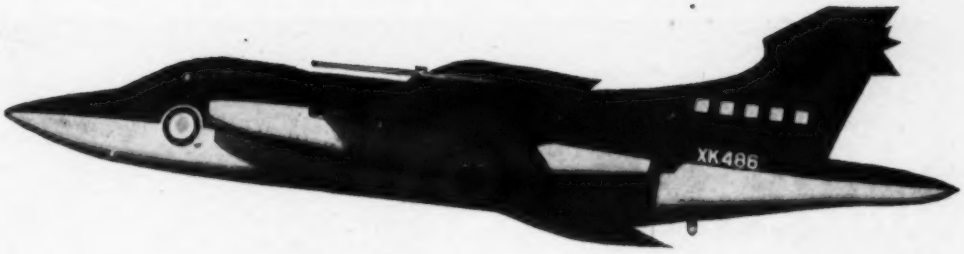
Weybridge, Surrey. Telephone: Weybridge 5555

Vigilant After cutting their teeth with such diverse weapons as a guided bomb, the Red Rapier pilotless bomber and the Red Dean air-to-air missile, Vickers undertook, as a private venture, the development of an exceedingly small anti-tank missile for infantry use. Known as the V.891 Vigilant this diminutive weapon has now reached an advanced state of development, and has already given a good account of itself during firing trials both in the United Kingdom and in the U.S.A. Design features include an airframe largely fabricated from reinforced plastics, wings of exceedingly low aspect-ratio, and wire guidance according to a velocity-type control, alterations to the flight path being effected by trailing-edge control surfaces. An extensive dissertation upon the complete weapon system was published in our issue of May 22 last.

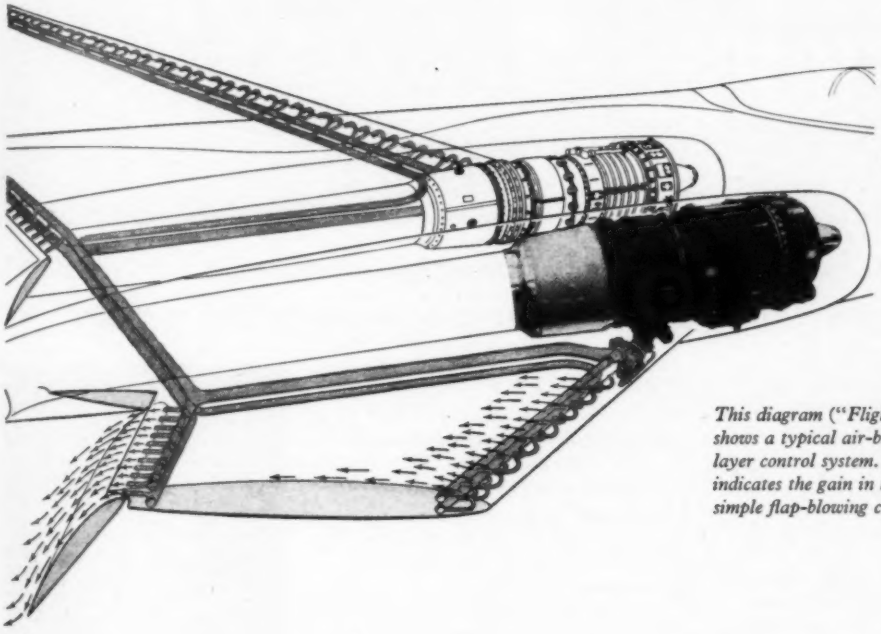
Vickers-Armstrongs Type 891 Vigilant Solid internal two-stage motor. Length, 32.25in; body diameter, 4.5in; wing span, 11in; weight of weapon in carrying case, with sight and cable, 35 to 40lb.

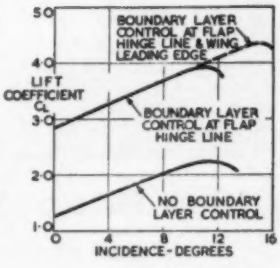


Vigilant being fired from a development launcher



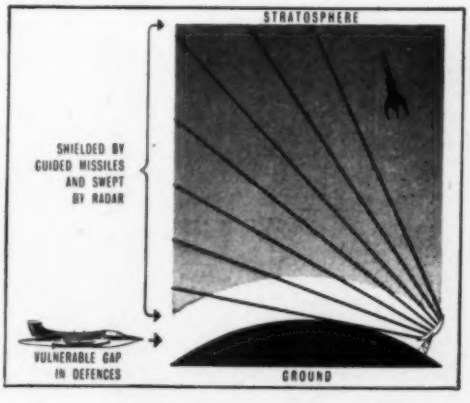
"The NA. 39 is ahead" *





This diagram ("Flight" copyright) shows a typical air-blowing, boundary layer control system. The graph indicates the gain in lift which simple flap-blowing can achieve.

Boundary layer control over the total span enables the NA.39 wing to attain the highest lift coefficient yet achieved on any high speed aircraft. Control and handling during take-off and landing are exceptional.



* *"In the low-level strike role, the NA.39 is ahead of any other aircraft in the world"*
Ministry of Defence

Blackburn

BLACKBURN AIRCRAFT LIMITED, BROUGH, YORKSHIRE

A140/a

MUCH MORE ENERGY FOR MUCH LESS WEIGHT

New Bristol Aerojet process produces gas storage vessels of great strength—high capacity—exceptionally low weight

High-pressure gas storage bottles have become an essential part of aircraft and guided missile systems. They provide a compact and efficient method of storing energy.

Bristol Aerojet, specialists in the design and manufacture of high tensile steel welded components, have developed a very advanced range of pressure vessels. Operating with great reliability at high stress levels, this new design provides unusually high energy storage capacity for exceptionally low weight.

Made of chrome molybdenum steel, the vessels are welded by the argon shielded tungsten arc process and heat treated to a minimum ultimate strength of 75 tons per sq in. All welds are examined several times during manufacture, both visually and radiographically and are subjected to the same stress as the parent material.

Bristol Aerojet pressure vessels are made in many specified shapes and range from 100 to 2,000-cu in capacity. When compared to forged vessels they show a weight saving of at least 5 lb per 500 cu in and as much as 50%.

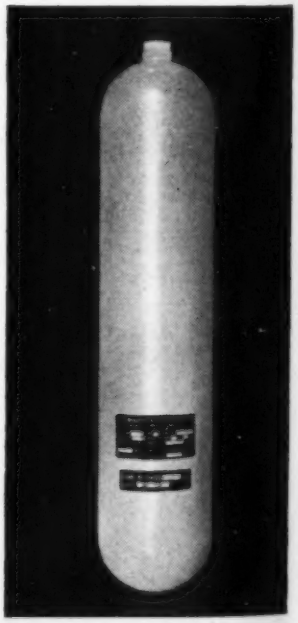
Bristol Aerojet Pressure Vessels Specified For Trans-Canada Vanguards

Trans-Canada Airlines have chosen Bristol Aerojet pressure vessels for the Elliot escape chutes in their 20 Vanguards.

Other companies supplied include:

BRISTOL AIRCRAFT LIMITED
BRISTOL SIDDELEY ENGINES LIMITED
DE HAVILLAND PROPELLERS LIMITED
WALTER KIDDE CO. LIMITED
BRITISH MESSIER LIMITED
THE PYRENE CO. LIMITED
A. V. ROE & CO. LIMITED
SAUNDERS-ROE LIMITED
SHORT BROS. & HARLAND LIMITED
VICKERS ARMSTRONG LIMITED

If you would like further information, about Bristol Aerojet pressure vessels or high tensile steel welded components, please write to: P. W. Lawson, Civil Sales Manager, Bristol Aerojet Limited, Banwell, Weston-Super-Mare, England. Telephone: Banwell 250.



Type 3135 Pressure Vessel Cylindrical (625 cu in)

Design ultimate pressure	5,000 psi
Maximum inflation pressure	2,500 psi
Free gas volume	1,470 litres
Weight	12 lb

ARB approved
Suitable for CO_2 fire extinguishers and pneumatic systems.

BRISTOL AEROJET

Accessory Manufacturers' Twelvemonth

THE WORK OF THE INDUSTRY IN 1959

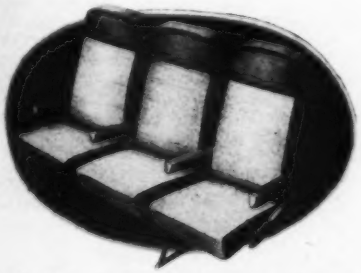
Indicative of the interest that is being displayed in the accessory industry is this recent picture of the Prime Minister, Mr. Harold Macmillan, during a visit to Teleflex Products. He is sampling the new inertia-lock shoulder harness and combined lap belt, which may be adopted by B.E.A.

THIS annual "Flight" review is concerned with products of the British aircraft accessory industry that have appeared for the first time within the past year, or those that have been extensively developed during this time. Within the compass of this and the following seven pages we hope to assist aircraft manufacturers' design, engineering and purchasing departments to keep abreast of the industry's new ideas and to appraise or remind the component industry of developments in other or competitive fields.

The conclusion to be drawn from this compilation is that prognostications of a major recession within the aircraft accessory industry during 1959 have proved unjustified. While it is true that the activities of some firms have been curtailed by dwindling demand, inventive capability has proved its effervescent quality by blossoming in other directions. The process of diversification has continued; and "new" concerns have appeared on the aeronautical scene. The work of 48 firms is reviewed below, all of them manufacturing airborne equipment—which must thus be judged to some extent by the manufacturers' success in saving weight. Aircraft ground equipment—a growing and competitive field—is another story about which we shall have much to say in the weeks that follow.

Aero Controls Ltd. The AC-Flex flexible couplings produced under licence by Aero Controls have been further developed during the past 12 months. These couplings are installed after the tubes to which they are fitted are in place, so that structural apertures need to be no larger than the standard bead on the tube. The advantages claimed for these fittings are that they accommodate ±4 deg tube flexure and that tubes on mating assemblies may be malaligned by as much as $\frac{1}{16}$in yet still allow movement of each coupling. Little more than hand tightening is required to achieve pressure tightness over a wide temperature range. The couplings embody the Wig-o-flex design.

Aircraft Furnishing Ltd. New airline chairs called Lonsdale Flyweight have recently been developed. They are tourist-class units which weigh 48 lb for the triple and 30 lb for the single. This is claimed to represent the "greatest weight reduction in aircraft seating ever achieved." Double seats of this type are being installed in the prototype Fairey Rotodyne and in the Avro 748 mock-up. The chair has been tested and A.R.B.-approved and is stressed for B.C.A.R. 9g forward- and aft-facing conditions. Special features are a shin clearance of between 14 and 15in, and a tip-up seat. What is described as "a combination of unique geometry of design and the transmission of forces by torque tube" is said to make the structure particularly safe when the seat is exposed to high deceleration forces.



Aircraft Furnishing's Lonsdale Flyweight triple seat unit

The Airscrew Company and Jicwood Ltd. Undoubtedly the most noteworthy project recently undertaken by the company has been the static blades and 7ft diameter fan for the Saunders-Roe Hovercraft. The fan blades were laminated from aerograde mahogany glued with waterproof synthetic resin and covered with special plastic and there is a metal sheath over the leading edge. The pre-rotational vanes were constructed from resin bonded Birch veneers built into a rigid central blanking which carries the nose fairing. The entire assembly was finished with aluminium bituminous paint.

The company's more conventional aircraft work has continued, and it is announced that Dragonair heater fans are being supplied for the Westland Wessex. Another single-stage/rotor unit cast in aluminium alloy is used for cooling the rotor gear box on the same helicopter.

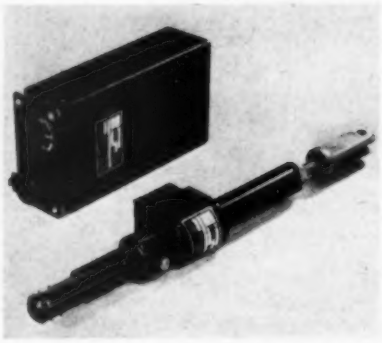
Sir W. G. Armstrong Whitworth Aircraft Ltd. Aircraft accessories marketed by A.W.A. are the products of the Armstrong Whitworth Equipment Division, formed recently by amalgamation of A.W.A.'s commercial electronic department and Gloster Technical Developments division.

One of the units originally developed by Gloster and now under the wing of the Equipment Division is a true mass-flow meter, which is quite insensitive to fluid density and viscosity and the accuracy of which is not affected by the rate of flow. Produced in prototype form last year, the unit is now being manufactured in its definitive version. It operates by adding angular momentum to the fluid and then removing this momentum by a restrained turbine so that the torque exerted on the turbine is proportional to mass flow. This is arranged by driving an impeller by a constant-speed motor, so that a constant angular velocity is imported to the fluid, and then measuring the amount by which the turbine deflects a spring in balancing the torque—this is proportional to the rate of mass flow. The motor is internal and drives the impeller through a train of gears and a magnetic coupling; its rotational speed is held constant (irrespective of voltage fluctuations in the 115V 400 c/s supply) by means of a velodyne velocity feedback. An induction pick-off converts the angular deflection of the restrained turbine into a voltage which is taken *via* a rectifier to the rate meter and through a second velodyne-controlled motor to operate the integrating counter.

Another development of the Gloucester factory is a force transducer system.

Guide vanes and ring for the Saunders-Roe Hovercraft were made by the Airscrew Company and Jicwood

Accessory Manufacturers' Twelvemonth...



(Left) A.W. Equipment Division's force transducer and indicator

(Right) Auto-Klean Lolos filter for the D.H. Gnome

Originally developed for the measurement of tensile and compressive forces in control linkages (to detect excessive out-of-balance forces in autopilot systems) it has also found several other applications, among them sensing and control in an automatic trimming system, as a test-bed instrument to measure engine thrust, or as an undercariage load indicator. Two units are involved, the transducer and an indicator. The former is directly connected into the linkage; it is of the variable-inductance type incorporating two magnetic circuits. Each of these has two separate coils and the four coils and bridge are connected to increase the sensitivity. The indicator comprises a demodulator to feed the centre-zero meter and a magnetic amplifier to supply the warning lamp, the brilliance of which is a linear function of force up to the warning limit.

Another unit developed during the year is an electro-hydraulic servo control system utilizing the principle of mark-space control. The maximum hydraulic flow is 22 cu in/sec at a total pressure drop of 900 lb/sq in and linearity is ±10 per cent from nominal.

Work of the Coventry factory has been concerned with the development of a high-speed sampling switch which will pass half-a-million readings a minute of strain, position, temperature, vibration and pressure while sampling two 24-channel banks. It can be used for relaying a mass of information at high speed from air to ground in aircraft or missiles.

Auto-Klean Strainers Ltd. Two new strainers designed by this company have been supplied to the de Havilland Engine Co. for the Gnome engine. Auto-Klean's "whole-hearted co-operation and rapid supply" received the thanks of de Havilland.

The lubrication oil-system strainer includes an Auto-Klean Lolos filter element with a 0.0015in mesh and cambric sleeves; the fuel-system strainer utilizes a Lolos filter of 0.0008in mesh with an aluminium body and cover and fitted with renewable felt sleeves.

Automotive Products Ltd. In conjunction with Lockheed Precision Products Ltd., this firm has been concerned during the past year with studies of hydraulic equipment for advanced commercial aircraft, including supersonic designs. A new component available for immediate use is the Lockheed full-flow relief valve, which is designed to prevent a dangerous build-up in pump pressure resulting from a system failure. The valve is adjustable from 1,000 lb/sq in to 4,000 lb/sq in and supplied in various sizes to suit flows up to 10 gal/min. Reseating pressures can be controlled to 90 per cent of the static relief pressure setting.

Avica Equipment Ltd. Much time has been devoted by the component industry during the past year to developing various types of flexible pipe joint. Avica have developed a gimbal-type, stainless-steel flexible joint for high temperature and high pressure systems. Special features of the design are that it is able to absorb axial compression and that it permits lateral offset and angular displacement between the connecting tubes. Use of stainless steel makes it suitable for rocket fuel and oxidant as well as for conventional aircraft fuels and air systems.

Lockheed Precision Products' electrically signalled undercarriage selector valve

Bell's Asbestos and Engineering Ltd. The trend towards pneumatic starting of gas turbine engines in commercial aircraft operation has led to the development of a range of proprietary equipment for this purpose. Collapsible air-starting hose which can be rolled for stowage is a Bell development and their new hose will handle air at up to 50 lb/sq in and 200-250 deg C. (picture, supplement page III).

Other recently developed products are a stainless steel wire mesh fire-seal with an oil-proof asbestos outer cover (which can be proofed with Viton "A" for higher temperatures) and a new V-flange universal clamp. The latter consists of segments which can be threaded on to a standard band clip; they will accommodate both 20 deg and 30 deg flanges and can be used for diameters from 1½in upwards.

Fire-seals in the Bell range have recently been improved. The D-section seal now incorporates a special grade of silicone sponge core with an oil-resistant, wire-reinforced asbestos cloth outer cover, and new types of garter-spring seals have been developed for engine and jet-pipe shrouds; these are in addition to the standard range of more orthodox bulkhead-type garter springs.

Boulton Paul Aircraft Ltd. Work on special instruments has occupied the firm during the past year. One such device is a high-accuracy differential manometer, a metallic bellows version of the Boulton Paul mercury bell-jar type of manometer which it supersedes. It uses the force-balance technique in conjunction with a dead weight and measures differential pressures in the region of 0-1,000 mm water gauge to an accuracy of one part in 10,000. Facilities for attaching a digitizer suggest that it is suitable for those applications where precise pressure measurement is required, coupled with the means of feeding information into a data-reduction system.

Another instrument is the Pendeford multimeter Mk 2, Pendeford being the name of the district in which the Boulton Paul works are situated. The Mk 2 version supersedes the original design and incorporates a number of improvements. The multimeter is a universal test instrument giving direct measurement of displacement, force, load or pressure by plugging in an appropriate transducer. Direct readings of strain can be made by connecting the instruments to strain-gauges, and remote indication is easy to achieve. The Mk 2 version is capable of driving a direct-inking recorder which has a response time of 0.15 seconds. Terminals are provided for attaching transducers in addition to plug connections and there is a wide selection of pre-set attenuation. It is now possible to set up the instrument to give a direct reading of the quantity being measured regardless of transducer sensitivity, and this enables many transducers of other than Boulton Paul manufacture to be used.

British Insulated Callender's Cables Ltd. New insulating materials and new techniques characterize the year's work of this company. A development with which they are particularly pleased is the production of stainless-steel-sheathed, mineral-insulated thermocouples. These have nickel-chromium and nickel-aluminium conductors and insulated hot junctions, and they range in size from 0.122in down to 0.060in overall diameter. Mineral insulated extension cables of similar construction have now been made in sizes down to 0.020in diameter—probably the smallest yet achieved.

A new high-temperature extension cable known as Cralefglas has also been recently developed. Chromel and Alumel conductors each have an insulation forming two separate extension leads which are individually identified by bi-coloured tape. Previously one overall sheath or two intertwined leads were used, but the new system is easier to seal when the cables are passed through a pressure bulkhead.

Another range which has been greatly developed is that of sub-miniature coaxial R.F. cables covering a complete range with overall diameters of less than 0.010in. One particular example is a copper-plated inner conductor now insulated with p.t.f.e. silver-plated copper wire braid and nylon (for minimum temperatures), or glass-braid silicone varnish or p.t.f.e. tape sheathing (for high temperatures). These cables are suitable for miniaturized electronic equipment and are claimed to have reached a more advanced state of development than any other of their type.

Bestobell V-clamp of segmented design

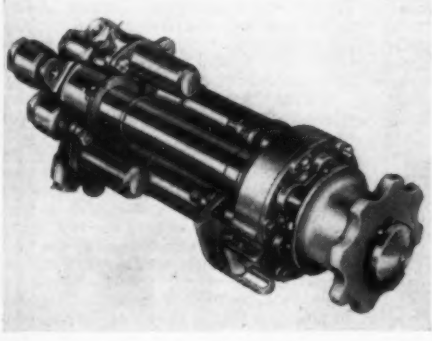
Accessory Manufacturers' Twelvemonth . . .

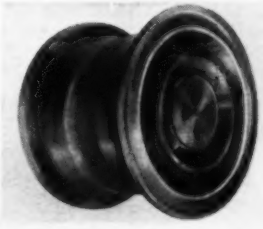
The British Thomson-Houston Co. Ltd. Now incorporated in the Motor and Control Gear Division of Associated Electrical Industries, B.T.H. have recently opened a new laboratory at Coventry for testing all constant-frequency power systems and for developing starter alternators. Under development are new power system components including magnetic amplifiers, potted and hermetically sealed units, silicone rectifiers, brushless alternators and various forms of switchgear and protective relays.

Development work during the year has been concerned with the iso-propyl nitrate turbo-starter, the advantages claimed for which are instant response, low electric current drain (up to one amp at 24V), a simple electric circuit, automatic shut-down in the event of a fractured pipe, fail-safe rotors and simultaneous engine starting. Various forms of breech have been devised, in particular integral breeches in one shot, two shot or three shot form. The last-named allows three charges to be fired successively, thus reducing frequency of reloading.

In the B.T.H. i.p.n. starting system the fuel is decomposed by a combination of heat and pressure only. The heart of the system is a fuel injector which acts rather like a liquid fuel cartridge; it comprises a cylinder, containing enough fuel for one start, and a spring-loaded piston. The start is initiated by a small cartridge weighing 70 grammes which is fired into the starter reaction chamber to provide heat and pressure. This acts behind the piston in the injector and initiates the flow of fuel to the starter chamber. Subsequent decomposition of fuel maintains the pressure needed to complete the full stroke of the injector piston. During this time the turbine wheel has produced sufficient torque to rotate the engine to a self-sustaining speed.

The total weight of the system varies from 59 lb to 75¼ lb for a single-start system or 67½ lb to 89 lb for a triple-start system.





Dunlop's fan-cooled aircraft brake

(Left) B.T.H. triple-breech iso-propyl nitrate starter

S. Davall and Sons Ltd. This horological firm is new to the aircraft component industry. The first of its aircraft products to be marketed are two new types of timing switch. One is a propeller and engine de-icing cyclic timer for mounting within a pressurized fuselage; it is controlled by conventional manual/automatic switch and operates remote B.T.H. interlocked contactors to make-and-break the supply feeds to the propeller spinner and engine air intake heater mats in specified fast or slow cycles. It is known as the Type 266 and it weighs 3½ lb.

The other device is an engine starting-sequence time switch, Type 219, which has been selected for use in the Vanguard and Rotodyne. It is based on similar principles to the Type 266 and weighs 2 lb.

"Diamond H" Switches Ltd. Although manufacture of this company's hermetically sealed miniature relays started in August 1958 they have come into full use only during the past 12 months. They are known as the B.S. series relays and all have a coil with a separately sealed compartment and switch unit built up on an inorganic insulated base. They are primarily intended for dry-circuit applications and are satisfactory for use in a circuit of 25 millivolts, 12 micro amp or lower.

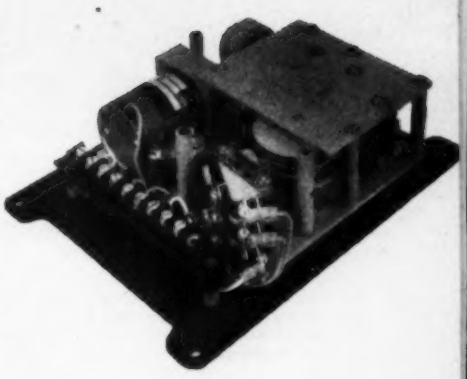
The B.R. series is of similar construction but is intended for more normal circuit applications on a rating of 10 amp, 30V D.C., 115V A.C. for resistive loading, and 5 amp 30V D.C., 115V A.C. inductive loading. Advantages claimed for them are that they have a high shock and vibration resistance, that their size and weight is low and that they operate over a wide temperature range—the B.R. series from −65 deg C up to 200 deg C, and for the B.S. series from −65 deg C to +125 deg C.

Dowty Group. The group, which now comprises Dowty Equipment Ltd., Dowty Fuel Systems Ltd., Dowty Equipment of Canada Ltd., Rotol Ltd., British Messier Ltd., and Dowty Seals Ltd., have produced a diverse range of equipment this year. A new undercarriage—for "a supersonic fighter"—is indicative of a trend in that it is machined from 120-ton steel. No auxiliary shock-absorbers are required to eliminate front-wheel slamming and the controlled articulation is a new feature covered by Dowty patent. In the field of powered flying controls a new dual-input actuator has been designed which is controlled by mechanical input or electrical signalling. As usual, the pilot can override the electronic control and can adjust the degree of authority left to it in accordance with flight conditions.

Rotol's contribution is the hydro-mechanical constant speed drive built under U.S. licence from the General Electric Company. It is a ball piston design and is well proven in service. Another licence-built product is the Moog valve—a compact amplifier of electronic signals with a high-power hydraulic output.

Ram air turbines have been further developed and a Rotol two-blade unit of 23in diameter and 35 max. h.p. has just been introduced.

Dunlop Rubber Co., Ltd. Improving turn-round times for transport aircraft may mean that quite heavy braking is often necessary in turning off the runway at a particular intersection. Dunlop have tackled the problem of obtaining sufficient brake cooling by evolving a fan-cooled brake which is claimed to reduce cooling time by as much as 80 per cent. The fan goes some way to reducing the difficulties attendant upon almost completely enclosing the heat-sink within the wheel so that little natural ventilation is possible. The fan is ducted and driven by a fractional-horsepower motor, and cooling times can be reduced from a typical 100 min to 13 min. The unit can be fitted into existing equipment without major modifications.

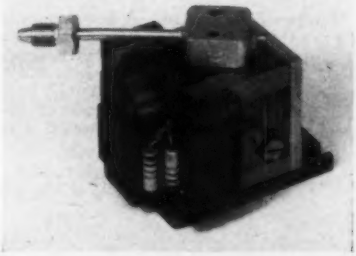


Davall Type 219 engine starting sequence controller, shown with cover removed

Elliott Brothers (London) Ltd. Earlier this year it was made known that Elliotts had been selected to provide a flight-control system for the Vickers VC.10. This is the Bendix/Elliott PB-20 which comprises two separate and identical systems each with its associated comparison monitor. Either system may be used for normal flying. The facilities provided are I.L.S. coupling with fully automatic throttle control, V.O.R. coupling, clutched and pre-set heading control and height and air speed Mach number locks. There are dual yaw dampers and dual automatic trims. The system is transistorized, with computing and amplifier elements in the form of plug-in card modules, a standard range of which have been designed to perform the various functions required in autopilot systems.

The powered controls of the VC.10 incorporate integrated electromechanical autopilot actuators. Under autocontrol the system operates in two ways. In the manual mode, damper demands with restricted authority are added directly to the pilot's demands. In the autopilot mode the power control position feed-back linkage is locked and replaced with an equivalent electrical feed-back. This allows a large increase in autopilot authority and also results in surface movements being transmitted into the control runs. The reaction force at the feed-back linkage locking point, which increases with movement of the runs against the artificial feel, is limited to some predetermined value to provide torque limitation. This integrated

Ferranti Ltd. hydraulic-jet valve for electro-hydraulic control of servo systems



Flight Refuelling's new fuel-hose pack for under-wing attachment

The Frankenstein-Beaufort 26-man survival raft with radar reflector

Accessory Manufacturers' Twelvemonth...

system, which is expected to provide more precise and stable control and a saving in weight in comparison with non-integrated systems, is the subject of an Elliott British patent.

Although there has as yet been no announcement about automatic landing systems being used on the VC.10, consideration has been given in the autopilot installation to the use of auto-flare and auto-landing. In these modes the detection of a malfunction will initiate automatic change over to control by the alternative autopilot system. Bendix announce that their 100 Series integrated instruments and flight director system and polar-path compass, both of which are built under licence, have also been specified for the VC.10.

Ferranti Ltd. Ferranti's latest products—both guided-missile accessories—are hydraulic-jet valves and a new accelerometer. The purpose of the jet valve is the conversion of a differential D.C. signal into a differential oil pressure. Two types are available; the range of differential input current is ±10mA for both types and the maximum differential output pressure is 700 lb/sq in for one type and 1,000 lb/sq in for the other. The input signal (150V D.C. supply) is fed into control coils which vary the position of a moving nozzle mounted on an armature spindle and fed with a high-velocity oil stream. Applied to the coil, this control signal displaces the moving nozzle so that the pressure in one hole is greater than that in the other, and this differential can be used directly to exert a load, or it could be applied *via* a servo valve.

The accelerometer is also produced in two types, one for the range ±10g and the other ±25g, and the instrument is contained in a sealed case filled with damping fluid. A spring-mounted inertia mass forms a shorted-turn element of an electrical pick-off consisting of a central energizing coil and two outer secondary coils. As the inertia mass moves from its central position under the influence of acceleration, the shorted turn moves in an air gap in the centre limb and thereby upsets the symmetry of the flux in the two outer limbs. Unequal e.m.f. are thus induced in the coils on the outer limbs, which produce a resultant e.m.f. proportional to acceleration.

In the aircraft equipment field the TR.500 transformer-rectifier unit has now gone into production and a number have been delivered to Vickers for installation in the Vanguard. Work also continues on Ferranti instruments and the Airpass radar and fire-control equipment (picture, supplement page xv).

Fireproof Tanks Ltd. A new departure for this firm is the construction of inflatable helicopter-pontoons, made from a sandwich of reinforced nylon/Terylene sheets joined by high-frequency welding. It is claimed that the shear strength of the welded seams (which are protected with cover strips) is equal to the strength of the base material. The pontoons are manufactured in units of one, two or three independent cells and the dividing bulkheads are constructed so that the welding edges are always in shear. Fittings on the outer sections are of anodized light alloy or stainless steel and each cell can be inflated independently through a standard type of Schrader valve.

Another development is a floating drop-fuel bag, made in the same way as the standard Fireproof flexible tanks. It can be picked up by a helicopter needing refuelling whilst airborne over the sea. Collapsible light-weight containers used for storage and transport of fuel, oil and other liquids are also being produced. They will fold or roll into a small pack when not required and are said to withstand prolonged use on rough ground under exposed conditions. They are supplied in capacities from five to 30,000 gallons.

Firestone Tyre and Rubber Co., Ltd. A new 46×16 tyre has been developed for the Boeing 707 after what the company describe as "exhaustive laboratory and operational tests." It has a high-speed tread with a straight ribbed pattern and has been developed to suit the high performance characteristics of the aircraft.

Firestone 46×16 jet-transport tyre

Tyres of the same pattern are also being made available for the Britannia and Comet at the request of B.O.A.C.

Firth Cleveland Instruments Ltd. Among the airborne equipment manufactured by this firm is a new integrated fuel flowmeter, now in production. It comprises a flow transmitter, electronic integrator, density corrector and cockpit indicator. The system (which was described in some detail on p. 56 of *Flight* for August 21) is flexible, and indications may be made in dual or multi-channel forms such as summated rate of flow, summated totalized flow, or summated totalized flow with separate indications of rate of flow.

Basic signals are generated by the magnetic rotor of the flow transmitter, signal frequency being proportional to the volumetric fuel flow. The signal emerges from the integrator, to which it is fed as two outputs; direct current proportional to rate of flow and pulses proportional in number to the total quantity of fuel passed. These signals are fed to the cockpit instrument. The range covered is 85 to 3,500 Imp. gal /min. (Picture, supplement page viii.)

Flight Refuelling Ltd. A new idea in air-to-air refuelling is the refuelling pack, a self-contained ram-air turbine unit designed to be attached to under-wing pylons. Refuelling with this unit can be carried out at speeds of up to 310 kt E.A.S. and at up to 45,000ft, and the pack and its attachment are stressed to withstand sonic speed. The Mk 20 pack is 13.5ft long and of 28in diameter, and apart from an electrical supply is quite self-contained. A Rotol ram-air turbine drives—through a two-stage centrifugal pump and pressure control gear—a hose reel capable of trailing some 55ft of 1½in-bore hose. The hose carries a coupling that is interchangeable internationally. The pack has a fuel capacity of 150 Imp. gal and it can be replenished from the aircraft to which it is fitted or, conversely, the fuel in the pack can be transferred back into the aircraft system.

The pack enables an aircraft to be converted from a tanker into its normal rôle in an hour, and it is intended particularly for single-seat aircraft. Empty, it weighs under 800 lb and will transfer fuel at a rate of 150 Imp. gal/min.

During the year Flight Refuelling have continued their development of several aircraft components. Among them is a 2in engine air-starter connection and a 4in hydrant-refuelling coupling. Another need has been met by the production of a switch which protects hydraulically driven fuel-flow proportioners during inverted flight. New types of valve continue to stem from the drawing boards at Tarrant Rushton, including fuel-no-air valves capable of pressure refuelling in one direction and transferring fuel in the other, various non-return valves, shut-off valves and equal-flow valves.

Frankenstein and Sons (Manchester) Ltd. A new type of airline life raft manufactured by this company's associate, Beaufort (Air-Sea) Equipment Ltd., is being supplied to Qantas and T.E.A.L. after testing in Australia, and is approved by the A.R.B. and by the A.R.B.'s Australian equivalent the D.C.A. The manufacturers have concentrated on speed of boarding—obviously important in icy or shark infested waters—and the new raft is reversible so that whichever way up it lands it is ready for use without rigging. Inflation is automatic and takes 17 seconds from the moment the mechanism is operated, and a boarding ramp has been included for easy entry in emergency.

Another feature is an inflatable canopy which provides shade and permits ventilation in hot climates and gives protective insulation in extreme cold. It is self-erecting in 20 seconds and permanently anchored by a central pillar, besides being secured by six columns around its circumference. Several sizes of raft are available, the largest being a 26-seater.

Among other developments being

UHF AIRBORNE TRANSMITTER-RECEIVER D.120

Incorporates new all-British electro-mechanical tuning system and circuitry, permitting pilot to select frequency and tune automatically to peak performance on any 12 channels in the 225-400 mc/s. band.

Easy-access crystals located at pilot's controller, enabling remote stowage of main equipment.

Of low weight (35 lbs.) and small volume, the set is constructed on the module, self-contained circuitry principle, which simplifies production, testing and maintenance, and gives excellent electrical and mechanical stability.

Designed for use with wide-band UHF Homer (D.128).

UHF HOMING EQUIPMENT D.128

Wide-band UHF Homer for use with 12-channel transmitter (D.120).

UHF/VHF TRANSMITTER-RECEIVER D.103

Lightweight (10 lbs.) two-channel set giving 10 mc/s. frequency band between 100 mc/s. and 280 mc/s. Operational ceiling 60,000 ft.

As Emergency Standby equipment, two versions available for 243 mc/s. or 121.5 mc/s. Both offer alternative frequency 1 mc/s. above or below main frequency.

Special portable UHF man-pack version (D.141), complete with batteries, for use by ground forces.

TRANSISTOR POWER SUPPLIES

30-watt, dual 60-watt and 120-watt units, all with silicon transistors and adequate heat sinks, for H.T. output up to 300 volts and nominal input of 28 volts D.C.

Alternative power ratings provided.

For operation up to 75 deg. C. ambient temperatures.

UHF TELEMETRY TRANSMITTER D.115

Fully sealed equipment comprising:

(i) Dual 60-watt power supply unit; (ii) Exciter unit; (iii) UHF amplifier.

Will transmit simultaneously data from 12 individual sources, using the 400 mc/s. band and giving 12 watts output.

Frequency modulated with maximum deviation 30 kc/s. Modulation frequency between 400 c/s. and 15 kc/s.

LF/UHF AIRFIELD AND INDUSTRIAL SECURITY COMMUNICATIONS SYSTEM D.126

A two-way controlled radiation communications system employing 15 oz. hand transmitter-receivers.

Control unit transmits on low frequency and receives on UHF.

Controlled radiation ensures security of all messages exchanged within prescribed area. 15 oz., all-transistor hand transmitter-receiver receives on low frequency and transmits on low power (100 milliwatts), on UHF.

Control unit can call and communicate with up to 14 individually coded out stations, or any number simultaneously on group call.

Our equipment has been, or is being, installed in the following aircraft:

HUNTER	JET PROVOST
WHIRLWIND	SEA HAWK
SEA VAMPIRE	METEOR
SEA VENOM	FOLLAND GNAT

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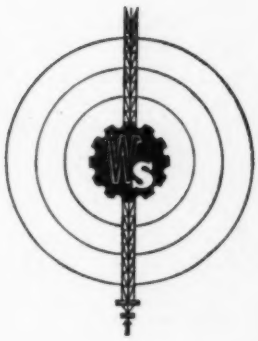

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Britain's deterrent relies on the most advanced weapon carriers...

...AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce two outstanding high-thrust turbojet engines—the Olympus and the Sapphire.

Between them these two engines power the most potent part of the RAF's strategic V-bomber fleet. The Olympus which delivers 17,000-lb thrust dry (24,000 lb with reheat) powers the Avro Vulcan. The Sapphire powers the Handley Page Victor. These engines give the V-bombers supersonic capability—long range —great altitude—superior performance to any other aircraft of their type in the world.

BRISTOL SIDDELEY ENGINES LIMITED

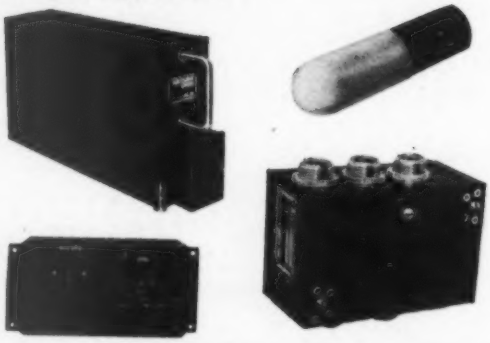
SUPPLY THE POWER

...e Bristol Siddeley Proteus powers ...e Britannia airliner. Four Proteus give ...is 130-seat aeroplane a speed of over 400 ...ph—a range of over 5,000 miles. Britan... ...s are in service with ten airlines and ...th RAF Transport Command.

The Star Sapphire car is powered by a Bristol Siddeley 4-litre engine. Combining great power with exceptional quietness and luxurious comfort, the new Star Sapphire has a top speed of over 100 mph and an outstanding all-round performance.

Bristol Siddeley Viper turbojets range from 1,640—3,000-lb thrust. Vipers power the Australian Jindivik, the Hunting Jet Provost, the Italian Macchi MB 326 (illustrated), and have proved their supersonic capabilities in mixed powerplant fighters.

AIRCRAFT EQUIPMENT



GROUND EQUIPMENT

Automatic landing, Leader cables and the S.B.A.C. display 1959

On Stand No. 200 in the static exhibition, Murphy Radio Limited will display among their range of aircraft equipment, the complete leader cable installations both ground and air.

The leader cable receiver provides accurate azimuth information which is fed to the auto-pilot during the critical stages of an automatic landing. At the same time, information is provided by a frequency modulated altimeter to give equally accurate altitude guidance. The auto-pilot installation, in addition to accepting this information, provides automatic throttle control throughout the entire procedure, including both 'flare-out' and 'throttles-off'.

Comprehensive monitoring is provided in the aircraft for checking the overall system to allow for 'break-off' should it become necessary at any time. Thus for the first time ever a system has been devised which will enable aircraft to land in "zero-zero" conditions. Furthermore, it is possible that leader cable guidance may be arranged so that the aircraft can use the system to taxi to the dispersal area.

This system was demonstrated in flight in a most impressive manner to an international audience at the Blind Landing Experimental Unit of the Ministry of Supply in October 1958 and a Static demonstration of the complete landing system will be shown on the Ministry of Supply stand during the exhibition.

We shall be pleased to receive visitors and show them the leader cable equipment on our own Stand No. 200 during the period of the exhibition and we feel confident that such a visit would prove of great interest.

keep in touch with ***murphy***

MURPHY RADIO LTD., ELECTRONICS DIVISION, WELWYN GARDEN CITY

Section through the fabric-reinforced-tread tyre developed by Goodyear for jet transports

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explored by Frankenstein-Beaufort are inflatable structures, flexible oil barges, inflatable water dams and high-altitude personal equipment for "possible future space age developments."

The General Electric Co. Ltd. The remarkable export success of this company includes sales to Aeroflot and to many American airlines. A new development—which is to be installed in Caravelles, DC-7s and DC-8s operated by S.A.S.—is an air circulation oven with three-heat control. It can handle up to 30 meals per loading, and can be used as a hot cupboard. G.E.C. say that wherever possible Sud Aviation has standardized on this equipment for its Caravelles.

Another new project is a hot cupboard capable of holding 21 meals, fitted with low- and high-heat control which keeps pre-cooked food at a suitable temperature. The company's hotcup and food containers have been improved by the addition of thermostatic control and the half-gallon water heater has been reduced in weight and now has a stainless steel interior.

Sir George Godfrey and Partners Ltd. A new unit now in production for two military aircraft is an airborne vapour-cycle refrigeration package, type VCP-1. It is mounted on a panel as an assembly and incorporates all the components required for a complete vapour-cycle refrigeration system with the exception of the condenser which, for installation reasons, is separate. A compressor/motor unit has been specially developed for the package, comprising a 400 c/s electric motor and Godfrey/SRM compressor enclosed in a hermetically sealed casing. Water/glycol is used as a coolant and circulated through an evaporator in the package, where the heat is transferred from the coolant to the refrigerant. Heat is finally rejected to a cooling flow of ram air passing through the condenser.

Godfrey are able to announce that they are supplying cabin compressors for the Canadair CL-44; compressors, cold air units, axial-fan turbine, feed-back valve and butterfly valve for the Vickers Vanguard, and a spill valve, cold-air unit and cabin supercharger for the Armstrong Whitworth Argosy.

For guided missile use the firm have developed a launcher electrical and air probe, a device for supplying cooling air and electrical power to a guided missile awaiting despatch in a launcher. It comprises a pivoted hollow steel probe arm carrying at one end a plug having 24 electrical contact pins and incorporating a special air valve. The pivoted end of the arm is connected to pneumatically operated link mechanism controlling the downward and forward movement of the arm and plug, the assembly being contained in a steel housing. In operation the door of the housing opens, the probe arm lowers and the plug is accurately located in a complementary socket provided in the tail of the missile. Engagement is completed in one second and disengagement in half a second. During the period the missile is in the launcher awaiting despatch a supply of electrical power and conditioning air is transferred to the plug through the monitoring and control circuits of the missile. The equipment is known as the type LEAP-1 Dev 6.

Goodyear Tyre and Rubber Co. (Great Britain) Ltd. A new range of tyres is being introduced which will be suitable for the take-off and landing speeds of jet transports. The design is called the fabric-reinforced tread tyre and the principal advantage claimed is that a greater number of landings can be obtained at high speed. The fabric reinforcement has been introduced into the tread in such a way that it follows the moulded contours of the ribbing.

If the danger of tread throwing is to be minimized the amount of skid depth which can be applied to the ribbing is limited, but fabric reinforcement enables the tread thickness to be increased by as much as one-third compared with a conventional tyre, and the likelihood of stone-bruising is reduced. Bruising is a major cause of tyre removal and the new design should provide more protection of the carcase from bruising or cutting damage during initial running. As the tyre wears down through the non-reinforced depth, bruise protection of the carcase is provided from the fabric reinforcement in a lessening degree until the tyre needs to be removed.

de Havilland Propellers Ltd. The Propeller Company have been extraordinarily prolific in their output of components and accessories during 1959. De Havilland propellers have been chosen for the CL-44 and for the D.H. Gnome, a fuel control system has been developed for the same engine and a synchrophasing system is another recent development. Other new equipment includes an air conditioning system for full-pressure suits and a vapour-cycle cooling system.

The CL-44 propeller is 16ft in diameter and has four aluminium alloy blades. The hydromatic principle is used for pitch change, and overspeed, pressure sensitive mechanical and hydraulic pitch locks, and automatic synchrophasing are included. The pitch locks operate automatically in the event of any failure in the propeller control system which would result in an uncontrolled movement towards fine pitch. Beta control is also included.

The Gnome propeller is three-bladed and 11ft in diameter. It can be supplied in three standards for different control systems: (a) constant speeding and feathering only; (b) constant speeding and feathering with fixed-pitch reverse operation; (c) constant speeding and feathering with Beta control for all ground operation.

Developed specially for the Gnome, D.H. Propellers' fuel-control system operates electrically but wiping contacts and moving parts other than those in the motor actuator have been avoided; use is made of high stability magnetic amplifiers with toroidal transductors. The control is powered by a transistor power supply built into the unit, the input source being the aircraft 24V battery. The facilities provided are: automatic starting circuits; temperature-control acceleration; top temperature limiter; ground idling speed governing; free turbine speed governing, using a method suitable for simple matching in a multi-engine application.

The air conditioning side of the company's activities has been advanced with a system for full-pressure suits. It is fed with high pressure, high temperature engine bleed air and delivers this control pressure, selected temperature and low humidity to the pressure suit. Provision is also made for emergency heating or cooling in the event of failure of the normal temperature control system. De Havilland Propellers have also produced a vapour-cycle cooling system employing a twin-cylinder reciprocating compressor driven by a swashplate hydraulic motor. The compressor speed controller maintains a constant evaporator outlet pressure by regulating compressor speed via a valve in the hydraulic supply.

The minimum evaporator temperature has been limited by introducing the flow limiter in the hydraulic supply line and this feature is said to be of particular significance for missile cooling.

H. M. Hobson Ltd. Two constant-speed alternator drives—the Types 368 and 369 of 30 kVA and 40 kVA output respectively—come under the category of equipment that has been extensively developed during the past year. These are hydro-mechanical variable-ratio drives which differ from others of their kind by the small proportion of torque that is transmitted hydraulically. Output speed is 6,000 r.p.m. constant to within ±1 per cent in each case and the input-speed range varies from 2,663 r.p.m. to 6,850 r.p.m.

This year Hobson have joined other firms that are producing recirculating-ball screw-jacks. The Hobson design is a high-precision type designed to replace conventional screw-jacks in such applications as flap actuators. It can be used with or without lubrication and maintenance costs should be reduced.

Honeywell Controls Ltd. An airborne take-off monitor is among the accessories introduced by this British associate of the U.S. Honeywell concern. Aircraft acceleration is used as a measure of any change in the aircraft's thrust or drag, and distance travelled is also recorded to give information on the distance remaining to refusal point. The operation is controlled by circuit interlocks to prevent premature abort signals and to prevent abort signals occurring after the aircraft has passed the refusal point.

"Sub-sub-miniature" micro-switches are another aircraft component on which development continues. Some designs are already in service and others will go into use with the NA.39 and Vanguard. Honeywell are also introducing into the United Kingdom the Honeywell-Atkins relative-danger light. This is a system of wing-tip mounted lights that flash to the front, sides and rear of an aircraft in three different frequency patterns: 160 flashes per minute to the front, 80 at the sides and 40 to the rear. The lights, which are of a blue-white colour claimed to have the greatest penetration, have a range which has been shown by tests to be twice that over which the aircraft itself can be seen—possibly up to 90 miles at night with definition "excellent" at 50 miles.

Hymatic Engineering Co., Ltd. In past years the company has produced many sizes of reducing valve for the aircraft industry. This year a new service is being offered by which more than 5,000 reducing-valve variants can be produced from standard modular elements covering a wide range of predicted performance—inlet pressures from 100 lb/sq in to 4,000 lb/sq in, outlet pressures from 1 to 500 lb/sq in, flows up to 30 standard cu ft/min

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and temperatures up to 300 deg C. In spite of the large number of variants these valves may not meet the requirements of every situation in which they are used, but they do provide off-the-shelf availability and as prototype units have the advantage of lower cost.

Among other recently developed valves are the PS.93 hot-air reducing valve, which has the dual function of full flow or reduction to a set downstream pressure. This particular valve incorporates a close-loop control system, and new design techniques have enabled the stability of new valves of this type to be reasonably accurately predicted. The PS.93 operates at temperatures up to 400 deg C and controls outlet air pressure to within $\pm\frac{1}{2}$ lb/sq in for flows up to 400 cu ft/min with inlet pressures up to 150 lb/sq in.

Hymatic AG.9/1 and AG.2/3 anti-g valves, which incorporate an automatic device to inflate the anti-g suit to a controlled pressure if cabin pressurization is lost, have now completed their development phase and are going into production.

Irving Air Chute of Great Britain, Ltd. Among the recent developments of this Letchworth firm is a light-weight automatic parachute for static seats. The canopy is a new Irving type designed to give improved stability with light weight and low bulk and it is fitted with a Terylene harness. An emergency oxygen set is housed in the parachute pack and the latest type of barometric power unit is fitted.

A safety belt has also been developed for mechanics working on aircraft surfaces or on servicing towers. It is stated to meet the performance test requirements of British Standard 1397 for a Type 2 belt.

The Walter Kidde Co., Ltd. Passenger emergency oxygen systems have recently been receiving the attention of many airlines introducing highly pressurized aircraft. The system developed by Walter Kidde now uses either light-weight cylinders for short-haul flights or liquid oxygen convertors for longer stages, and the control system has been considerably developed. It functions in four modes: (a) With the pipelines in the passenger cabin dry when no oxygen is required. (b) With the passenger system at 40 lb/sq in for general therapeutic use. (c) If cabin altitude exceeds normal limits the pipeline pressure is increased to 80 lb/sq in and causes masks to drop out ready for use. (d) At 40 lb/sq in made for post-emergency flight conditions and therapeutic use.

The system includes a new type of mask which operates like a demand mask but without its disadvantages—it will operate as a constant-flow mask if it is not correctly fitted to the face.

In an attempt to overcome the encumbrance of an aircrew oxygen mask that has to be worn throughout normal flight, a quick-donning mask has also been devised that is easily stowed on the flight deck.

The company have also turned their attention to the manufacture of glass fibre radomes for which they claim an accuracy of 0.004in on diameter and 0.001in on wall thickness. Hot-cured polyester resin and glass roving is used, wound on to a steam-heated male former, semi-cured and then ground to an accuracy of 0.001in. It is claimed that radome units as large as 5ft in diameter and 15ft long are completely free from electrical aberration and radar wave distortion, and manufacturing costs are said to be cheaper than laying out layers of glass mat and resin on to a former.

Lodge Plugs Ltd. Still quite a new Lodge product are thermocouples for the measurement of gas temperature in turbine engines. Some years development work went into the design before it was marketed and Lodge say that their thermocouples are gaining a reputation for long life and reliability. A similar claim is made for the RS35R sparking plug, which was developed as a replacement for the original plug specified for use in the Wright Turbo-Compound engine. The plug is in use by ten airlines and has been approved by the A.R.B. for 1,050 hours in B.O.A.C. aircraft. It has platinum electrodes and Sintox alumina ceramic insulation; periods of 750 to 1,000 hours without removal for cleaning or gap setting are said to be not uncommon.

Joseph Lucas (Gas Turbine Equipment) Ltd. While development of fuel pumps, fuel controls, burners and other combustion equipment continues, the firm have produced as a 1959 offering a new quick-release coupling for use in aircraft hydraulic, fuel and oil systems. It is claimed that uncoupling can easily be accomplished with one hand, even if the pipes are under the full pressure of their fuel content, yet the coupling remains locked at pressures over 12,000 lb/sq in.

The normal working pressure range is up to 3,000 lb/sq in and temperature range up to 100 deg C. The coupling weighs 10 oz and employs a spring-loaded ballrace catch locking mechanism. Poppet valves, which are normally opened when the coupling is locked, close on to their seatings to prevent fuel leakage when the two components of the coupling are disconnected. The coupling unit for a $\frac{3}{4}$in pipe diameter is just over 3in long and has an overall diameter of 1.75in; other sizes can be supplied for specific installations.

For some time past Lucas have been working on the design of special sealing rings which are manufactured to very fine limits. Developed originally by the Lucas G.T.E. applied research laboratory for use in Lucas equipment, these O-rings have now been made available for aircraft hydraulic systems and industrial applications. Synthetic rubber is used and there is a range of internal diameters of 0.114in to 5.875in.

Martin-Baker Aircraft Co. Ltd. Here is another firm where work during the past year has been on the development of an already promising existing design. The Mk 4 BS fully automatic ejection seat is fitted to the English Electric Lightning and is typical of seats being supplied to many air forces.

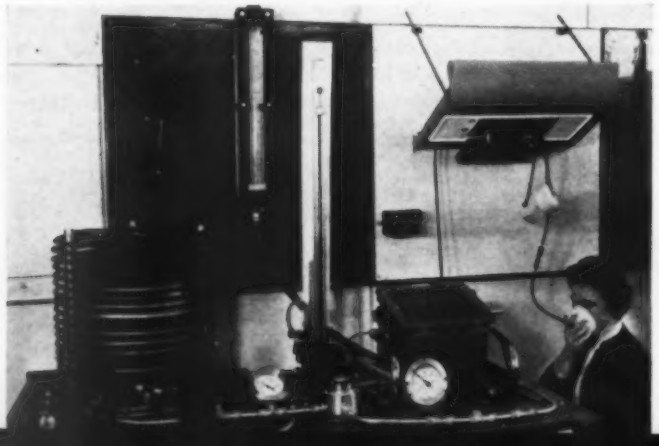
A new feature is the electrically operated seat-raising mechanism which replaces the old seat-pan raising handle, for which many cockpits have no space to spare. The actuator consists of a 28V D.C. motor driving a screw jack attached to the bottom cross member of the seat structure, operation of the switch on the seat-pan raising or lowering the seat as required. The seat is normally equipped with the survival pack P.S.P. Type V containing a single seat dinghy and the usual survival equipment.

Negretti and Zambra Ltd. Now available from this old-established instrument firm is a direct reading fuel flow integrator which gives a full-scale reading of 100,000 kg of fuel in intervals of 10 kg. Electrical supply is 115V 400 c/s A.C. reduced in stages by rectification to 140V D.C., reduction to a constant 75V supply to the motor circuit and again reduced to 24V for feeding across a high impedance rheostat. In contact with the rheostat is a pick-up which is directly linked to the fuel flow rate-indicator shaft; since the angle of displacement of this shaft is linear with the flow rate the voltage taken from the rheostat at the pick-up is directly proportional to the flow rate. This voltage is fed to the integrator motor whose shaft speed is directly proportional to the applied voltage and the shaft rotation is imparted through reduction gearing to a cyclometer, the reading of which will hence be a true integral of fuel flow-rate with time.

The scale of accuracy is indicated by rate calibrations to within $\pm\frac{1}{4}$ per cent of the full scale reading, including transmission errors. Additional error, dependent upon range and fuel, may be introduced at low temperature. The integrated reading is claimed to be maintained within ± 2 per cent of the integrated quantity, provided that the average rate of consumption is not less than 20 per cent of the full scale reading.

Normalair Ltd. The company have recently been concentrating on the design and supply of complete aircraft pressurization, air conditioning and oxygen systems, and in particular on vapour-cycle cooling and passenger oxygen equipment. Their

(Left) Walter Kidde oxygen mask and convertor (Below) Lucas Avon and Conway fuel control unit



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vapour cycle cooling designs have been based on an aircraft of the VC.10 class and are of 15-ton capacity. Pneumatic power is used for operation and control and the system is based on a new two-stage compressor driven by an air turbine.

Normalair's new passenger oxygen equipment includes a mask which is claimed to be economical in the use of gas and to be pliable enough to give a good seal against the face. A therapeutic point on each set enables emergency oxygen to be administered to individual passengers during normal pressurized flight. Associated with the passenger equipment is a new liquid-oxygen supply system. This is based on what is becoming known as the "crew reserve" principle, in which a single storage vessel can be used to supply passenger oxygen and at the same time constitutes a reservoir exclusive to the crew.

Another development is an electro-pneumatic temperature-control system. Cabin and duct temperatures are sensed pneumatically and the resultant signals are resolved into a pneumatic system to regulate the temperature of the control valve. It is claimed for this system that it has the advantages of both electric and pneumatic systems without the disadvantages of either. Electric sensing reduces the installation weight and the pressure loss of a long pneumatic sensing line, and pneumatic control and operation does away with heavy and sometimes unreliable electric actuators.

Plannair, Ltd. Recently developed are a range of five air movement units for the Vickers Vanguard. Typical of these are a 9in model developing 1,300 cu ft/min for cabin air recirculation, and a 4in model with an output of 1 cu ft/min and intended for fire warning. The latter fan draws air from selected parts of the aircraft and feeds it to a smoke-detection device.

Another pair of blowers have been developed for heating and ventilating the main cabin of the Bristol 195 and demisting and cabin ventilation on the Westland Westminster. Silencing is a new feature introduced by the company, who claim that high performance can now be obtained with quiet running. The space within the exterior surface of the circular blower housing and end flanges has been packed with sound absorption material held in place by an outer wrapper plate. Noise vibrations are absorbed by specially situated components provided in the main blower housing.

Power Auxiliaries Ltd. A seamless, flexible metallic hose meeting the requirements of the A.R.B. and F.A.A. has been developed during the past 12 months, and so has a new pre-curving technique which can be applied to all Power Auxiliary hoses and ducts. Pre-curving is intended to give a compact run and to be suitable where neatness of installation is particularly required. An additional advantage claimed for this technique is that the end-fittings are relieved of much of their lateral load. Other developments are Plessiflex Type A ducting for low-pressure air systems, lined Plessiflex hose for piping cartridge gas in engine starter systems, and new end-fittings for quick release self-sealing couplings.

Precision Rubbers Ltd. The development of many new materials has occupied the firm over the last 12 months. These include Viton Prescolastik silicone rubbers, polyurethane lacquers and rubbers resistant to Skydrol. Viton is a fluorocarbon rubber offered in two types of compounds covering the hardness ranges of 57-86 in general-purpose grades and 76-92 in low compression-set grades. The material is used for O-rings, seals, diaphragms and small bonded components, is resistant to oils and fuels and is heat-resistant to 300 deg C for the former material and 250 deg C for the latter.

The Prescollan lacquer S.63 is resistant to abrasion and tearing and is said to be particularly suitable for preventing rain erosion on radomes and other external glass-fibre parts.

Prescolastik silicone rubbers are offered in a range which is said to be the widest available in Europe; all are resistant to fuels and to H.T.P. Another use of this silicone material is for aircraft-fuselage pressure seals.

Rotax Ltd. Although few new types of component have appeared from Rotax during the year, development has continued on brushless alternators, ram-air and bleed-air turbo-alternators and transistorized invertors, and a number of new designs have been produced.

In particular, the oil-cooled 40kVA brushless alternator (picture, supplement p. VII) has been intensively developed; the elimination of brush-wear problems at altitude remains a major advantage of this type of machine.

New electrical units include an unbalanced over-voltage protection unit, two types of control unit which are particularly suitable for use with invertors operating at high temperature, and two new D.C. electric starters, one for 24V and the other for 28V supply.

The unbalanced over-voltage protection unit mentioned earlier is the type F.7302, which takes its rectified D.C. supply from a transformer-rectifier unit connected to a regulated 3-phase busbar voltage. With normal balanced voltages on the primary of the 3-phase transformer only a small current flows in the relay coil, because this current is a measure of the ripple appearing in the D.C. output of the 3-phase bridge rectifier. In the event of a fault in the supply lines causing an increased voltage in two lines and decrease in the third, the increased ripple current will cause the relay to operate. The degree of unbalance necessary to trigger the relay will depend upon the values of feed condenser, resistance and the sensitivity of the relay chosen. If a fault occurs on any pair of lines between the protection unit and any equipment on the busbars, the three line-voltages will be out of balance, depending on the severity of the fault. When this condition arises the relay will energize a time-delay thermal switch which will in turn energize the trip circuit, thus disconnecting the faulty unit. If a single line between the alternator and the protection unit becomes open circuited, the out-of-balance voltages will cause the unit to operate. This unit will not operate on a symmetrical 3-phase fault.

Sangamo Weston Ltd. Changes in the loading conditions of a 3-phase electrical system can be sensed by the 3-phase failure warning system developed by this company. It is sensitive to variations of total load or changes in phase balance. The system comprises three current transformers, an integrating unit and a moving-coil relay. One of the three transformers is incorporated in each phase of the system and the output is fed into the integrating unit, which supplies an output large enough to operate the moving coil relay which provides the failure indication. A switch is provided on the integrating unit to cater for nominal loads. One application in which the system is already used is to give warning of de-icing equipment failure in the Fairey Gannet.

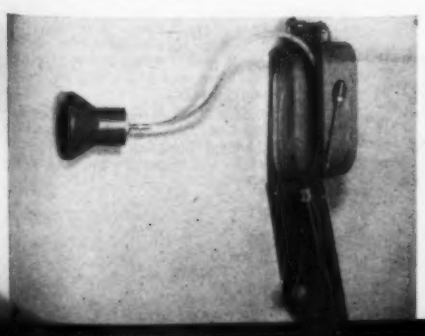
Saunders Valve Co. Ltd. New this year is a liquid-oxygen valve fitted with a pneumatic actuator. It makes use of the well known Saunders spherical plug design and the torque is low enough for manual or pneumatic operation to be used. The Mk 4 valve was recently submitted to tests involving 5,000,000 operations, which it completed successfully.

Saunders have also been working on an H.T.P. pump, the Saffran self-priming centrifugal unit with 2½in suction and discharge branches designed to deliver 230 gal/min with a suction lift of 25ft, and running at a speed of 2,700-3,000 r.p.m. The working pressure is 85-100 lb/sq in. Saunders state that the system of venting and sealing prevents fluid being trapped in the seal, and that no H.T.P. leakage can occur when the pump is either running or stationary.

Serck Radiators Ltd. The fuel-cooled oil cooler on the de Havilland Gnome is a Serck product. It is specially tailored for installation in the high pressure fuel system and has been kept as light as possible. The matrix is fully detachable for cleaning and to relieve thermal stresses and it incorporates a built-in relief valve.

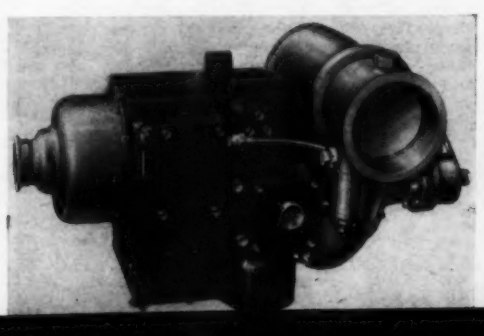
Short Bros. and Harland Ltd. Shorts have continued their development of aircraft seats with a new light-weight design, the SM.700. It is intended for economy-class passengers and is now being produced in double and triple units which weigh less than 20 lb per passenger. Floor clearance at the rear is 15in, so that legroom is reasonable even at 32in pitch. To reduce access problems with six-abreast seating tip-up seats and arm rests have been provided.

Normalair passenger oxygen presentation



Saunders lox valve

Rotax bleed air turbo-alternator



(Left) Serck oil cooler for the Gnome engine

Teddington's "hot rod" ice detector

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Smart and Brown (Machine Tools) Ltd. Development of new and better types of special plugs and connectors is apparently limitless. Four new types have been produced by this firm. One is a prototype plug and socket for use at temperatures of 150 deg C, another includes a range of co-axial connectors developed in conjunction with the Ministry of Supply, English Electric and the Plessey Company, and the others are special purpose co-axial connectors suitable for relay applications, and plugs and sockets with stainless steel shafts. The second item mentioned is noteworthy inasmuch as it represents a new attempt at standardization. The range, known as U.K.C., is a much improved version of the American "C" series of co-axial connectors because the pins are captive and a double clamping device prevents the cable being pulled away.

Sperry Gyroscope Co. Ltd. A remarkably wide range of new products has been developed by Sperry this year. Among these are the vertical gyro for automatic control of instrumentation systems on which Sperry is working in collaboration with Smiths for the D.H.121. It weighs 4 lb and involves a conventional movement of improved performance.

Another device is a turbine vibration pick-up—the gas turbine equivalent of the piston-engine ignition analyser. The pick-up is a transducer for generating electrical signals according to the vibration to which their sensitive elements are subjected. These are mounted at selected points on an engine installation and can be incorporated in an electrical warning circuit so that any abnormal vibration is detected in time to take remedial action.

Although no firm conclusion has yet been reached about ideas for displaying information on the windscreens of aircraft, the subject has been much discussed in recent years. Sperry have now produced a visual flight director for displaying instrument information on the windscreen by optical means. The pilot can make use of it while looking out of the cockpit, and without having to alter the focus of his eyes. The system is a further development of the zero reader technique and represents another step in providing pilots with full facilities for bad weather landings.

A new radio aid is the radio track guide. This is an airborne analogue computer which transforms navigational information from ground-based radio aids by the use of two co-ordinates of Loran C, Decca, Dectra, Gee or Vortac, together with route data contained in a small punched-card programme, into signals which indicate aircraft position as a tracking error and "distance-to-go" with respect to a required track. The tracking signal output can then be applied directly to a flight director system or to an automatic pilot.

The particular application suggested is for *en route* civil flying, when the track consists of a succession of straight lines. To define these lines the co-ordinates of each pair of terminal points are programmed so that a full track will be represented by a series of turning points. With a radio track guide coupled to an automatic pilot it would be possible to fly a radio track automatically and in accordance with a pre-set programme of turning points. Problems of air traffic control would to some extent be simplified, since the system can also make use of duplicated punched cards for simple automatic computers and displays within A.T.C. centres. Ground and air trials conducted with the Decca system have shown the possibilities of using—as a result of improved accuracy—as many as six laterally separated tracks within each existing airway.

Among a range of new instrument devices is the Rotorace Gyrosyn compass, in which counter-rotations are applied to gyro-sensitive axis bearings to average out frictional torques, and a twin gyro stable platform. The latter provides altitude and heading reference from a single stable platform incorporating two identical Rotorace gyros. These are orientated at right angles to each other and gimballed in such a way that the platform establishes not only the heading reference but also a vertical in the aircraft. This gives a reference "of inertial quality" without the use of floated gyros. Combined with Doppler it is said to provide a very accurate low-weight navigational system.

Work on inertial systems has led to the development of a precision single-axis accelerometer. It operates on the force feed-back principle and has a linearity of better than 0.1 per cent with a zero stability better than 6×10^{-4}g.

Teddington Aircraft Controls Ltd. A wide range of equipment has been developed in recent months. One, an ice warning device, consists of a moisture-sensing head, a dry-bulb temperature senser and a control box.

The moisture-sensing head detects free water by the measurement of the resistance difference between two heated temperature-sensitive resistance windings, one of which is in the wet airstream and the other which is in a dry airstream. Drying is effected by momentum separation of the water. This unit can detect a free water content of 0.1 grammes/cu m—the acknowledged threshold for ice formation. The dry-bulb senser will switch at some temperature close to 0 deg C and these two signals when in series in the control box give an indication of icing.

One of the company's latest developments is the visual icing indicator known as a hot rod. This is simply a matt-black metal rod projecting into the airstream in view of the pilot. It is equipped with a floodlight for night use and has a heater within the mast so that the pilot may de-ice it. Its simple purpose is that it should ice-up more readily than components of the aircraft and thus provide a visual indication of the ice hazard.

For cabin temperature control, a field in which this company specializes, a temperature senser known as the Ductstat has been introduced. It consists of a low-mass resistance element in the form of an insulated nickel wire wound on a former. These units, bridge connected, form the basis of temperature control; the bridge off-balance is amplified in the equipment by transistorized amplifiers which provide relay switching of control and control actuators. Prototype units have been built in which the relays are laminated and the amplifier drives direct to a two-phase A.C. motor.

It is desirable in controlling cabin temperature to have anticipatory control, and this is provided to some extent by the Teddington outside-air-temperature element. This exists in two forms—one with the resistance element sandwiched between two thin plates which can become part of the aircraft skin, and the strain-gauge type of temperature-sensitive resistance which can be stuck to the inside of an unheated portion of the aircraft skin. Its purpose is to correct proportional servo droop and control over the total system-range and at the same time to act as a bridge-connected temperature sensitive element.

Teleflex Products Ltd. New from Teleflex is an inertia-lock crew harness. It is claimed to be about 2½ lb lighter than any conventional harness and requires no adjustment to the shoulder straps, so allowing crew members to lean about the cockpit in performance of their duties. Should the wearer be thrown from his seat in any direction the harness locks automatically. A control is provided which in the "automatic" position allows movement but locks at decelerations in excess of 1½g and a manual position which converts the assembly into a fixed harness stressed for 25g.

"THE ANCILLARY INDUSTRY": ADDENDA

SINCE the directory to products and services on pages I-XXVI of this issue closed for press additional information has been received, and the products of the undermentioned companies should be added. We suggest that members of the industry who are keeping the directory for reference (as many do) should note the details against the relevant sections.

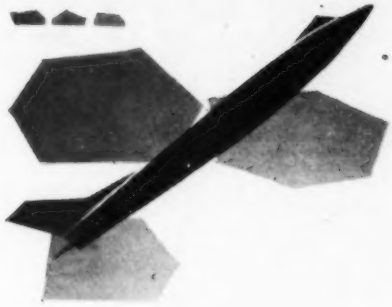
B. and F. Carter and Co. Ltd., Albion Works, Bolton, Lancs. T: Bolton 4344. TA: Braiders, Bolton. Machinery for the manufacture of braided and wrapped hose, metallic or rubber. Also precision measuring and counting instruments; and centrifugal clutches and variable-speed gears.

Fox and Sons (Aviation) Ltd., C. J., 117 Victoria St., S.W.1. T: Victoria 0204/5. TA: Eyebolts, London. "Kaylock" lightweight all-metal self-locking nuts; flaw-detection fluid.

R. F. Components (Cheltenham) Ltd., 17 Lansdown Place Lane, Cheltenham, Glos. T: Cheltenham 52470. Spark-erosion cutting; general precision engineering, jigs and fixtures, press tools.

Royston Instruments Ltd., Canada Road, Oyster Lane, Byfleet, Surrey. T: Byfleet 4356. Design and manufacture of electronic, electro-mechanical and optical instruments; magnetic-tape data-recording and processing equipment for the aircraft industry.

Smith and Co. Ltd., Eric H., 71 Almners Road, Lyne, Chertsey, Surrey. T: Chertsey 2908. Agricultural aviation equipment, consultancy, design and experimental work, drawing-office services.



Dramatic weight-reduction in airborne search radar!

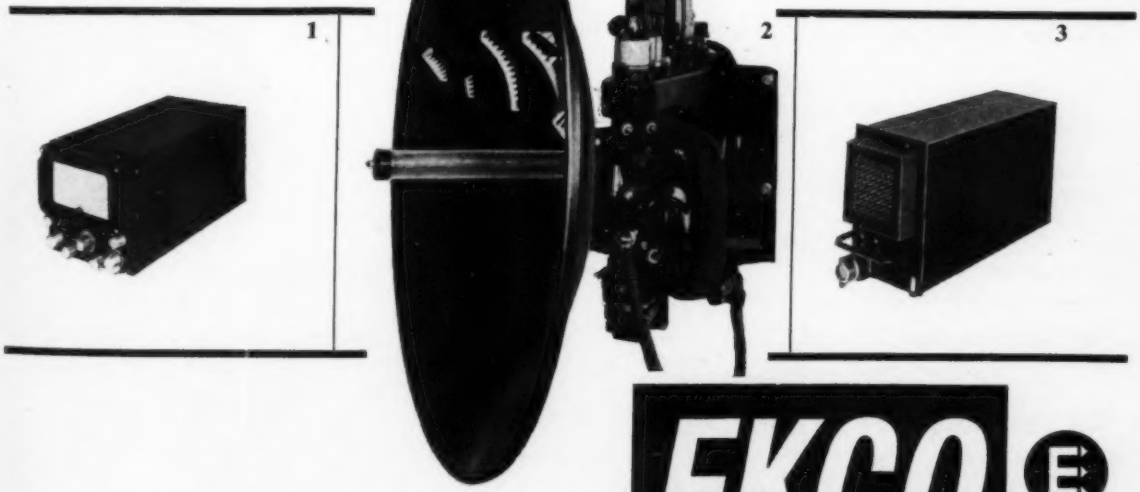
EKCO LIGHTWEIGHT SEARCH RADAR

Ekco, first in the world with commercial Airborne Search Radar, now announce yet another major Ekco advance in this field—EKCO Lightweight Search Radar.

This new equipment reduces the total weight to only 56 lbs—less than half that of previous systems! Yet, Ekco Lightweight Search Radar provides all the facilities of a modern Weather Radar System, including a fully-stabilised 24in antenna, 150 mile range and high brightness display.

The reduction in size and number of units, made possible by the extensive use of transistors, allows a consequent saving in installation costs and mounting weight.

These three compact units make up the new Ekco Lightweight Search Radar:—
1 Indicator.
2 Scanner.
3 Transmitter receiver.



SEE IT AT FARNBOROUGH

Together with Automatic VHF/DF Equipment
Airfield Approach Aids, Transistorised Inverters

EKCO

ahead in electronics

EKCO ELECTRONICS LTD · SOUTHEND-ON-SEA · ESSEX

FOLLOW THE ROUTE of

PAN AMERICAN AIRWAYS

QANTAS

KLM

B.O.A.C.

FIELDS AIRCRAFT SERVICES

BUY the DOUGLAS Tugmaster

For handling your aircraft up to 300,000 lb. weight.

Two and four-wheel-drive tractors available 30,000 lb. tractive effort.

Fully automatic transmission.

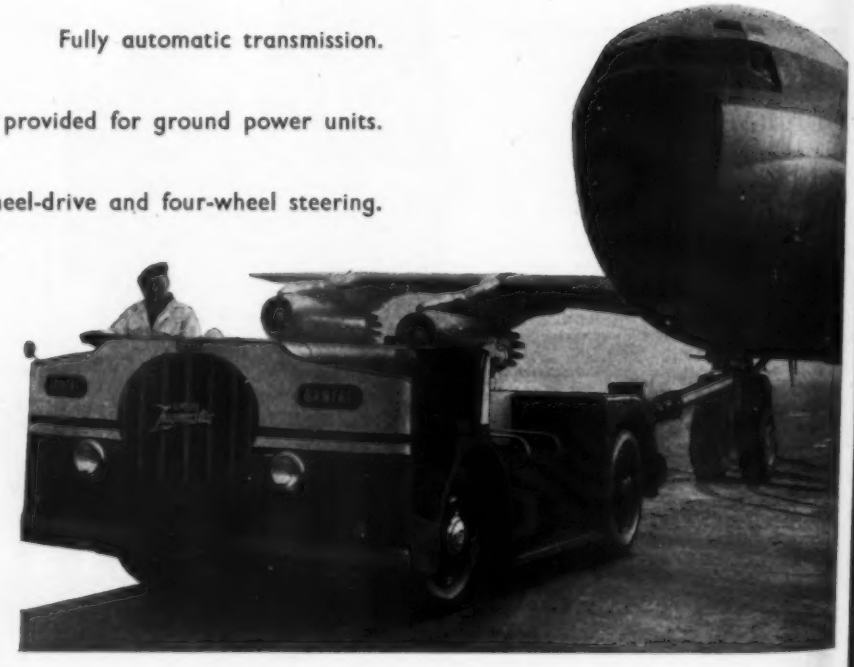
Space provided for ground power units.

Also available with four-wheel-drive and four-wheel steering.

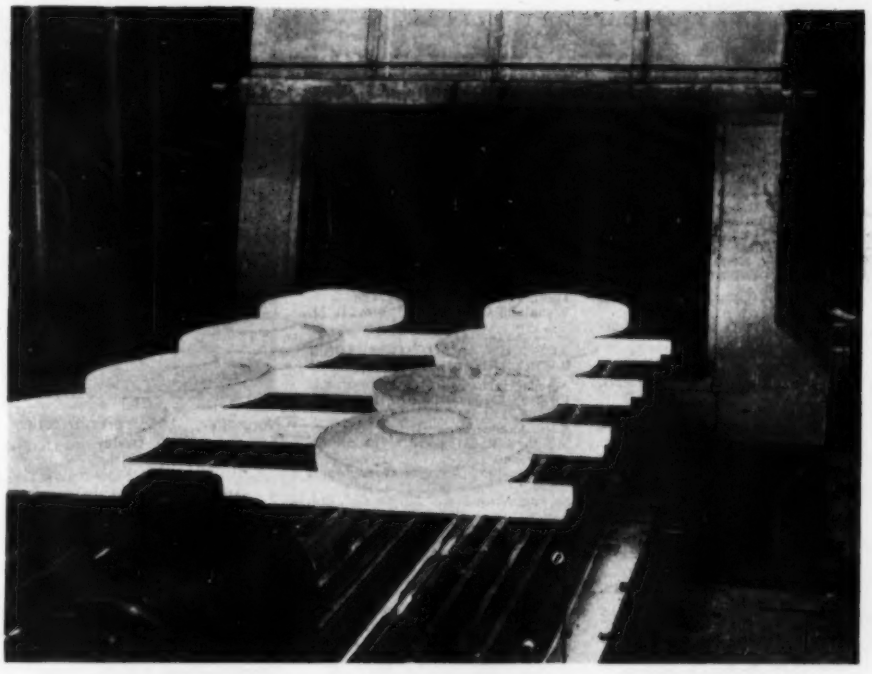
Two pedal control.

230 b.h.p. engine.

Power assisted steering.



Drop-forged turbine discs being withdrawn from a dual-system heat-treatment furnace before transfer to an air-cooling table (The Firth-Derihon Stampings Ltd.)



A "FLIGHT" READY-REFERENCE DIRECTORY TO PRODUCTS AND COMPANIES

Ancillary Industry 1959

IN this special directory section of "Flight" over 400 components, accessories, services, etc., are listed in quick-reference form, and under the headings are names of some 550 United Kingdom firms whom we understand to be manufacturers or suppliers of such items. Their addresses, with telephone numbers and telegraphic registrations, are given alphabetically at the end of the products directory. Aircraft, engines and missiles are dealt with in the special reviews earlier in this issue, as are new developments in certain classes of major equipment. "Aerial work" operations are not included; they have their place in others of our special numbers. A great many of the items named are obtainable through agents, such as those listed under ten headings on this and the next page.

A.G.S. PARTS
Accles and Pollock, Ltd.
Aero Controls, Ltd.
Aeronautical Trades and Manufacturing Co., Ltd.
Aircraft Materials, Ltd.
Attewell and Sons, Ltd., B.
Aviation Developments, Ltd.
B.M.B. (Sales), Ltd.
Baxters (Bolts, Screws and Rivets), Ltd.
Brown Bros. (Aircraft), Ltd.
Coopers Mechanical Joints, Ltd.
Cross Manufacturing Co. (1938), Ltd.
Curd Components, Ltd.
Dowty Seals, Ltd.
Fairey Aviation, Ltd.
Guest, Keen and Nettlefolds (Midlands), Ltd.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Kautex, Ltd.
King Aircraft Corporation
Newton, Ltd., L. H.
Page Engineering (Sunbury on Thames), Ltd.
Parsons, Ltd., J. R.
Plessey Co., Ltd., The
R.M.R. Engineering
Rawlplug Co., Ltd., The
Rubery Owen and Co., Ltd.
Simmonds Aerocessories, Ltd.
Spring Washers, Ltd.
Stone and Co. (Deptford), Ltd., J.
Terry and Sons, Ltd., Herbert
Torrington Co., Ltd., The
Tucker Eyelet Co., Ltd., Geo.
Unbrako Socket Screw Co., Ltd., The
Whitehouse Industries, Ltd. (Phillidas Division)

ABRASIVES
Abrasive Developments, Ltd.
Minnesota Mining and Manufacturing Co., Ltd.

ACCUMULATORS, HYDRAULIC
Dowty Equipment, Ltd.
Fawcett, Preston and Co., Ltd.
Lockheed Precision Products, Ltd.
Palmer Aero Products, Ltd.
Reynolds Tube Co., Ltd.
Rotol, Ltd.

ACTUATORS
Duvall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Dunlop Rubber Co., Ltd.
Eastern Aero Electrical Services, Ltd.
Electro-Hydraulics, Ltd.
English Electric Co., Ltd., The
Fairey Aviation, Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Hercules Engineering Co., Ltd., The
Hobson, Ltd., H. M.
Hymatic Engineering Co., Ltd., The
Miles, Ltd., F. G.
Plessey Co., Ltd., The
Rotax, Ltd.
Turner Manufacturing Co., Ltd.
Ultra Electric, Ltd.
Vernons Industries, Ltd.
Wilmot Breeden, Ltd.

ADHESIVES
Aircraft Materials, Ltd.
B.B. Chemical Co., Ltd.
Bakelite, Ltd.
British Paints, Ltd.
CIBA (A.R.L.), Ltd.
Docker Bros.
Fireproof Tanks, Ltd.
Imperial Chemical Industries, Ltd.
Jablo Propellers, Ltd.
Kane, Ltd., Douglas
Kenilworth Manufacturing Co., Ltd.
Minnesota Mining and Manufacturing Co., Ltd.
Rawlplug Co., Ltd., The
Rotol, Ltd.
Surridge's Patents, Ltd.
Titanine, Ltd.

AERIALS (AIRCRAFT RADIO, ETC.) AND EQUIPMENT
Amphenol (Great Britain), Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Belling and Lee, Ltd.
Chelton (Electrostatics), Ltd.
Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
Decca Navigator Co., Ltd., The
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Gloster Technical Developments Division
International Aeradio, Ltd.
Lancefield Aircraft Components, Ltd.
McMichael Radio, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Miles Structural Plastics, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Racal Engineering, Ltd.
Sanders (Electronics), Ltd., W. H.
Standard Telephones and Cables, Ltd.

AGENCIES AND DISTRIBUTORS, AIRCRAFT
Aero-Enterprises (Boreham Wood), Ltd.
Aircraft and General Finance Corporation, Ltd.
Airline Air Spares, Ltd.
Dundas, Ltd., R. K.
Field Aircraft Services, Ltd.
Helicopter Sales, Ltd.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Rollason Aircraft and Engines, Ltd.
Shackleton, Ltd., W. S.
Walter, Ltd., A. J.
Warden Aviation and Engineering Co.

AGENCIES AND DISTRIBUTORS, COMPONENTS, SPARES AND SMALL PARTS
Aerocontacts (Aircraft Distributors), Ltd.
Aero-Enterprises (Boreham Wood), Ltd.
Aeronautical Trades and Manufacturing Co., Ltd.
Aircraft and General Finance Corporation, Ltd.
Airline Air Spares, Ltd.
B.R.D. Co., Ltd.
B.S.T. Aeronautical Co., Ltd.
Dundas, Ltd., R. K.
Eastern Aero Electrical Services, Ltd.
Field Aircraft Services, Ltd.
Honeywell Controls, Ltd.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Phillips and White, Ltd.
Quality Bearings, Ltd.
Rollason Aircraft and Engines, Ltd.
Shackleton, Ltd., W. S.
Stewart Aeronautical Supply Co., Ltd.
Walter, Ltd., A. J.
Warden Aviation and Engineering Co.

AGENCIES AND DISTRIBUTORS, ENGINE
Aerocontacts (Aircraft Distributors), Ltd.

Continued overleaf

ANCILLARY INDUSTRY 1959...

Aircraft and General Finance Corporation, Ltd.
Airline Air Spares, Ltd.
B.R.D. Co., Ltd.
B.S.T. Aeronautical Co., Ltd.
Dundas, Ltd., R. K.
Helicopter Sales, Ltd.
Phillips and White, Ltd.
Shackleton, Ltd., W. S.
Walter, Ltd., A. J.
Warden Aviation and Engineering Co.

AGENCIES AND DISTRIBUTORS, FACTORY AND AIRFIELD EQUIPMENT

Aerocontacts (Ground Equipment), Ltd.
Aeronautical Trades and Manufacturing Co., Ltd.
Field Aircraft Services, Ltd.
Gordon and Co.
Headland Engineering Developments, Ltd.
Kane, Ltd., Douglas
Research and Control Instruments, Ltd.
Smith Sections
Stewart Aeronautical Supply Co., Ltd.

AGENCIES AND DISTRIBUTORS, HELICOPTER SPECIALIST

Field Aircraft Services, Ltd.
Helicopter Sales, Ltd.
Hordern-Richmond, Ltd.

AGENCIES AND DISTRIBUTORS, INSTRUMENT

Aerocontacts (Sales), Ltd.
Airline Air Spares, Ltd.
B.S.T. Aeronautical Co., Ltd.
Dundas, Ltd., R. K.
Electro Mechanisms, Ltd.
Flexonics, Ltd.
Honeywell Controls, Ltd.
Phillips and White, Ltd.
SFIM (Great Britain), Ltd.
Short and Mason, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Wynn and Co. (Aircraft), Ltd., E. D.

AGENCIES AND DISTRIBUTORS, MATERIALS (METALLIC)

Aerocontacts (Sales), Ltd.
Airline Air Spares, Ltd.
Dundas, Ltd., R. K.
Gordon and Co.
LR Airsteel, Ltd.
Mining and Chemical Products, Ltd.
Rapp, Ltd., Leo
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

AGENCIES AND DISTRIBUTORS, MATERIALS (NON-METALLIC)

Aerocontacts (Sales), Ltd.
Airline Air Spares, Ltd.
Dundas, Ltd., R. K.
Kane, Ltd., Douglas
Lewis, Ltd., D.
Vane and Co., A. H.

AGENCIES AND DISTRIBUTORS, ELECTRICAL AND ELECTRONIC

Aerocontacts (Sales), Ltd.
Airline Air Spares, Ltd.
B. S. T. Aeronautical Co., Ltd.
Dundas, Ltd., R. K.
Eastern Aero Electrical Services, Ltd.
Honeywell Controls, Ltd.
Murphy Radio Ltd. (Electronics Division)
Phillips and White, Ltd.
Research and Control Instruments, Ltd.
SFIM (Great Britain), Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Wynn and Co. (Aircraft), Ltd., E. D.

AGENCIES AND DISTRIBUTORS, RADIO AND RADAR EQUIPMENT

Aerocontacts (Sales), Ltd.
B. S. T. Aeronautical Co., Ltd.
Dundas, Ltd., R. K.
Field Aircraft Services, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Research and Control Instruments, Ltd.
Stewart Aeronautical Supply Co., Ltd.

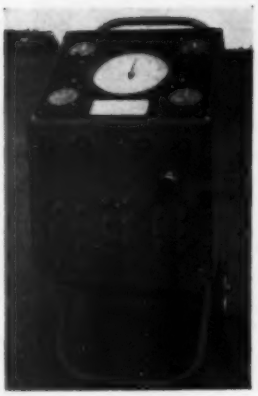
AGRICULTURAL AIRCRAFT EQUIPMENT

Agricultural Aviation Co., Ltd.
Brown Construction Equipment Ltd., David
Delaney Gallay, Ltd.
Fison-Airwork, Ltd.
Miles Structural Plastics, Ltd.

AIR CONDITIONING AND PRESSURIZATION EQUIPMENT

Avica Equipment, Ltd.
Avimo, Ltd.
B. M. B. (Sales), Ltd.
Bell's Asbestos and Engineering, Ltd.
de Havilland Propellers, Ltd.
Delaney Gallay, Ltd.
Dunlop Rubber Co., Ltd.
English Electric Co., Ltd., The
Flexible Ducting, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Godfrey and Partners, Ltd., Sir George
Gordon and Co.
HML (Engineering), Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Hymatic Engineering Co., Ltd., The
King Aircraft Corporation
M. L. Aviation Co., Ltd.
Normalair, Ltd.
Palmer Aero Products, Ltd.
Plannair, Ltd.
Serck Radiators, Ltd.
Ted Jington Aircraft Controls, Ltd.

The senior air traffic control officer at Southend Municipal Airport passing bearing information to aircraft by means of the new Ekco V.H.F. automatic direction finder



Normalair, Ltd., pressurization test trolley

AIR SURVEY EQUIPMENT

Fairey Air Surveys, Ltd.
Hendrey Relays, Ltd.
Mechanism, Ltd.
Williamson Manufacturing Co., Ltd.
Young, Ltd., A. W.

AIR TRAFFIC CONTROL SERVICES AND EQUIPMENT

Airmed, Ltd.
Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
Decca Navigator Co., Ltd., The
Ekco Electronics, Ltd.
Hercules Engineering Co., Ltd., The
International Aeradio, Ltd.
Kelvin and Hughes (Aviation), Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Mechanism, Ltd.
Philips Electrical, Ltd.
Pye Telecommunications, Ltd.
Redifon, Ltd.
Spurling Motor Bodies, Ltd.
Thermionic Products (Electronics), Ltd.
W. S. Electronics

AIRFIELD CONSTRUCTION

Brown Construction Equipment, Ltd., David
Costain, Ltd., Richard
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)

AIRFIELD CONSTRUCTION EQUIPMENT

Brown Construction Equipment, Ltd., David
General Electric Co., Ltd., The
Harley Aircraft Landing Lamps
Hercules Engineering Co., Ltd., The
Van Moppes and Sons (Diamond Tools), Ltd., L. M.

AIRFIELD MANAGEMENT

Derby Aviation, Ltd.
Field Aircraft Services, Ltd.
International Aeradio, Ltd.
Simon Engineering (Midlands), Ltd.

AIRSCREWS—see Propellers

ALLOYS, FERROUS

Aircraft Materials, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Brown Bayley Steels, Ltd.
Brown Bros. (Aircraft), Ltd.
Firth and John Brown, Ltd., Thos.
Fox and Co., Ltd., Samuel
Jessop-Saville, Ltd.
Kiveton Park Steel and Wire Works, Ltd.
United Steel Companies, Ltd., The

ALLOYS, FUSIBLE

Mining and Chemical Products, Ltd.

ALLOYS, HEAT-RESISTANT

Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Hadfields, Ltd.
Jessop-Saville, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Titanium Metal and Alloys, Ltd.
United Steel Companies, Ltd.
Wiggin and Co., Ltd., Henry

ALLOYS, HEAVY

Birkett, Billington and Newton, Ltd., T. M.
General Electric Co., Ltd., The
Gordon and Co.
Stone and Co. (Charlton), Ltd., J.
Tungum Co., Ltd., The

ALLOYS, LIGHT

Aircraft Materials, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Birmetals, Ltd.
Booth and Co., Ltd., James
British Aluminium Co., Ltd., The
Brown Bros. (Aircraft), Ltd.
High Duty Alloys, Ltd.
Imperial Chemical Industries, Ltd.
Magnesium Elektron, Ltd.
Mills, Ltd., William
Northern Aluminium Co., Ltd.
Rapp, Ltd., Leo
Reynolds T. I. Aluminium, Ltd.
Rollet and Co., Ltd., H.
Southern Forge, Ltd.
Sterling Metals, Ltd.
Stone and Co. (Charlton), Ltd., J.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

ALTERNATORS

Bosch, Ltd.
British Thomson-Houston Co., Ltd., The
de Havilland Propellers, Ltd.
Eastern Aero Electrical Services, Ltd.
English Electric Co., Ltd., The
General Electric Co., Ltd., The
Godfrey and Partners, Ltd., Sir George
Houchin, Ltd.
Newton Bros. (Derby), Ltd.
Rotax, Ltd.
Rotol, Ltd.
Vernons Industries, Ltd.

ALUMINIUM

Aluminium Corporation, Ltd.
Birmetals, Ltd.
Booth and Co., Ltd., James
British Aluminium Co., Ltd., The
British Insulated Callender's Cables, Ltd.
Gordon and Co.
Kaye, Ltd., E. and E.
Kent Alloys, Ltd.
Mills, Ltd., William
Northern Aluminium Co., Ltd.
Rapp, Ltd., Leo
Reynolds T. I. Aluminium, Ltd.
Rollet and Co., Ltd., H.
Sterling Metals, Ltd.
Stone and Co. (Charlton), Ltd., J.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

ARMAMENT (GUNS) AND COMPONENTS

British Manufacture and Research Co., Ltd.
Crossley (Packings), Ltd., Henry
Dunlop Rubber Co., Ltd.
Hercules Engineering Co., Ltd., The
M.L. Aviation Co., Ltd.

ARMAMENT (OTHER THAN GUNS) AND COMPONENTS

(see also Guided-weapon equipment)

British Manufacture and Research Co., Ltd.
Brown, Ltd., S. G.
Davall and Sons, Ltd., S.
Ferranti Meters, Ltd., Denis
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Hunting Engineering, Ltd.
M.L. Aviation Co., Ltd.
Martin-Baker Aircraft Co.
Smart and Brown (Machine Tools), Ltd.

ASBESTOS AND ASBESTOS COMPONENTS

(see also Refractory materials)

Bell's Asbestos and Engineering, Ltd.
Crossley (Packings), Ltd., Henry
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Turner Bros. Asbestos Co., Ltd.

ASSEMBLIES, MAJOR AIRFRAME

Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
Boulton Paul Aircraft, Ltd.
Chinn and Co., Ltd., J. S.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
English Electric Aviation, Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Handley Page, Ltd.
Miles, Ltd., F. G.

Parnall and Co., Ltd., George
Portsmouth Aviation, Ltd.
Samlesbury Engineering, Ltd.
Saunders-Roe, Ltd.
Scottish Aviation, Ltd.
Vickers-Armstrongs (Aircraft), Ltd.
Walter, Ltd., A. J.
Western Manufacturing (Reading), Ltd.
Wilmot Breeden, Ltd.

ASSEMBLIES, SUB-
Abbey Panel and Sheet Metal Co., Ltd.
Aero Controls, Ltd.
Aircraft Materials, Ltd.
Aviation Traders (Engineering), Ltd.
Bell Precision Engineering Co., Ltd.
Bell's Asbestos and Engineering, Ltd.
Burnley Aircraft Products, Ltd.
CJC Developments (Portsmouth), Ltd.
C. and N. (Electrical), Ltd.
Chinn and Co., Ltd., J. S.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
Davall and Sons, Ltd., S.
Delaney Gallay, Ltd.
Eastern Aero Electrical Services, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Erith Engineering (Leicester), Ltd.
Fairey Marine, Ltd.
Field Aircraft Services, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Miles, Ltd., F. G.
Mollart Engineering Co., Ltd., The
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Redwing, Ltd.
Reynolds Tube Co., Ltd.
Samlesbury Engineering, Ltd.
Sankey and Sons, Ltd., Joseph
Saunders-Roe, Ltd.
Saunders-Roe (Anglesey), Ltd.
Scottish Aviation, Ltd.
Short and Mason, Ltd.
Spa Guilds, Ltd.
Tungum Co., Ltd., The
Walter, Ltd., A. J.
Western Mfg. (Reading), Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.

Starting-air hose by Bell's Asbestos (50 lb/sq in at up to 250 deg C)

AUTOMATIC PILOTS
Elliott Bros. (London), Ltd.
Fairey Aviation, Ltd.
M. L. Aviation Co., Ltd.
Newmark, Ltd., Louis
Smiths Aviation Division
Sperry Gyroscope Co., Ltd.
Walter, Ltd., A. J.

AUXILIARY POWER UNITS
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
British Thomson-Houston Co., Ltd., The
Coventry Climax Engines, Ltd.
de Havilland Engine Co., Ltd., The
Plessey Co., Ltd., The
Rover Gas Turbines, Ltd.
Savage, Ltd., W. Bryan
Venner Accumulators, Ltd.
Vernons Industries, Ltd.

BAGS, COTTON, ETC.
(for small parts)
Acrogalley
Feltham and Son, Ltd., Walter H.

BAGS, LIFTING, AIRCRAFT
Dunlop Rubber Co., Ltd.
R.F.D. Co., Ltd.

BALLOONS, METEOROLOGICAL AND RESEARCH
M.L. Aviation Co., Ltd.

BALLOONS, TRAINING
R.F.D., Co., Ltd.

BARRIER CREAMS
Cellon, Ltd.
Imperial Chemical Industries, Ltd.
Rozalex, Ltd.

BATTERIES
Bosch, Ltd.
Burndept, Ltd.
Chloride Batteries, Ltd.
Lucas, Ltd., Joseph
Oldham and Son, Ltd.
Peto and Radford
Rotax, Ltd.
Siemens Edison Swan, Ltd.
Varley Dry Accumulators, Ltd.
Venner Accumulators, Ltd.

BEARINGS, BALL
B.M.B. (Sales), Ltd.
E.M.O. Instrumentation, Ltd.
Fischer Bearings Co., Ltd.
Hoffmann Manufacturing Co, Ltd.
Quality Bearings, Ltd.
Ransome and Marles Bearing Co., Ltd.
Skefko Ball Bearing Co., Ltd., The
Walter, Ltd., A. J.

BEARINGS, ROLLER
British Timken, Ltd.
Fischer Bearings Co., Ltd.
Hoffmann Manufacturing Co., Ltd.
Ransome and Marles Bearing Co., Ltd.
Salter and Co., Ltd., Geo.
Skefko Ball Bearing Co., Ltd., The
Torrington Co., Ltd., The

BEARINGS
(other than ball and roller)
Aero Controls, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
R.M.R. Engineering
Rose Bros. (Gainsborough), Ltd.
Stone and Co. (Charlton), Ltd., J.
Vandervell Products, Ltd.
Yorkshire Engineering Supplies, Ltd.

BELTS, DRIVING
Bell's Asbestos and Engineering, Ltd.
Turner and Co., Ltd., Luke
Turner Bros. Asbestos Co., Ltd.

BELTS, PASSENGER SEAT
Aerolex, Ltd.
Lancefield Aircraft Components, Ltd.
Latex Upholstery, Ltd.
Siebe, Gorman and Co., Ltd.

BLADES, GAS TURBINE
B.R.D. Co., Ltd.
de Havilland Engine Co., Ltd., The
Fairey Aviation, Ltd.
Firth and John Brown, Ltd., Thos.
Firth-Derihon Stampings, Ltd., The
Garringtons, Ltd.
Hadfields, Ltd.
Hepworth and Grandage (Yeadon), Ltd.
Hercules Engineering Co., Ltd., The
High Duty Alloys, Ltd.
Wilmot Breeden, Ltd.

BOLTS—see A.G.S. Parts

BOLTS, LEAKPROOF
Dowty Seals, Ltd.
Kane, Ltd., Douglas

BONDED RUBBER—see Rubber

BONDING, RESIN
Bakelite, Ltd.
CIBA (A.R.L.), Ltd.
Ferranti Meters, Ltd., Denis
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd.

BRAKES (AIRCRAFT) AND COMPONENTS
(see also Tyres and Wheels)
Electro-Hydraulics, Ltd.
Girling, Ltd.
Goodyear Tyre and Rubber Co. (Great Britain), Ltd., The
Hercules Engineering Co., Ltd., The
Palmer Aero Products, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Walter, Ltd., A. J.

BRASS
Birkett, Billington and Newton, Ltd., T. M.
Booth and Co., Ltd., James
Imperial Chemical Industries, Ltd.
Rollet and Co., Ltd., H.
Stone and Co. (Charlton), Ltd., J.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

BRONZE
Birkett, Billington and Newton, Ltd., T. M.
Booth and Co., Ltd., James
Kent Alloys, Ltd.
Rollet and Co., Ltd., H.
Stone and Co. (Charlton), Ltd., J.
Yorkshire Engineering Supplies, Ltd.

BUILDINGS, AIRFIELD AND FACTORY
Booth and Sons (Bolton), Ltd., John
Costain, Ltd., Richard
Gordon and Co.
Jablo Propellers, Ltd.
Morfax, Ltd.
Scottsey, Ltd., Tom M.

Ball bearings by Ransome and Marles Bearing Co., Ltd.

CABLES, CONTROL, AND ACCESSORIES
Aircraft Materials, Ltd.
British Insulated Callender's Cables, Ltd.
Brown Bros. (Aircraft), Ltd.
Fairey Aviation, Ltd.
Grundy and Partners, Ltd.
Palmer Aero Products, Ltd.
Savage, Ltd., W. Bryan
Sciaky Electric Welding Machines, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Teleflex Products, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The

CABLES, ELECTRICAL
Avica Equipment, Ltd.
British Insulated Callender's Cables, Ltd.
Fairey Aviation, Ltd.
General Electric Co., Ltd., The
Grundy and Partners, Ltd.
Plessey Co., Ltd., The
Reliance Cords and Cables, Ltd.
Rist's Wires and Cables, Ltd.
Rotax, Ltd.
St. Helens Cable and Rubber Co., Ltd.
Sciaky Electric Welding Machines, Ltd.
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Telegraph Construction and Maintenance Co., Ltd., The

CALIBRATION EQUIPMENT
Amal, Ltd.
Cossor Instruments, Ltd.
Davall and Sons, Ltd., S.
E. M. I. Electronics, Ltd.
English Electric Aviation, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Gloster Aircraft Co., Ltd.
Graseby Instruments, Ltd.
Graviner Colnbrook
Hercules Engineering Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
Munro, Ltd., R. W.
Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Waymouth Gauges and Instruments, Ltd.
Wayne Kerr Laboratories, Ltd., The
Wynstruments, Ltd.

CAMERAS, AERIAL
Direct Photographic Supply Co.
Fairey Aviation, Ltd.
Vinten, Ltd., W.
Williamson Manufacturing Co., Ltd.
Young, Ltd., A. W.

CAMERAS, RESEARCH
Armstrong Whitworth, Ltd., Sir W.G.
Cossor Instruments, Ltd.
Direct Photographic Supply Co.
Fairey Aviation Ltd.
Gloster Technical Developments Division
Southern Instruments, Ltd.
Vinten, Ltd., W.
Williamson Manufacturing Co., Ltd.
Young, Ltd., A. W.

CANOPIES, COCKPIT
(see also Plastics)
Attewell and Sons, Ltd., B.
English Electric Aviation, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Miles, Ltd., F. G.
Palmer Aero Products, Ltd.
Samlesbury Engineering, Ltd.
Suntex Safety Glass Industries, Ltd.

CANOPY ACTUATION AND JETTISON EQUIPMENT
Electro-Hydraulics, Ltd.
English Electric Co., Ltd., The
Hymatic Engineering Co., Ltd., The
M. L. Aviation Co., Ltd.

CAPACITORS
British Insulated Callender's Cables, Ltd.
Plessey Co., Ltd., The
Salford Electrical Instruments, Ltd.
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.

CAPSULES, PRESSURE-RESPONSIVE
Appleby and Ireland, Ltd.
Davall and Sons, Ltd., S.
Kelvin and Hughes (Aviation), Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Mechanism, Ltd.
Munro, Ltd., R. W.
Negretti and Zambra, Ltd.
Normalair, Ltd.
SFIM (Great Britain), Ltd.

CARAVANS
Portsmouth Aviation, Ltd.
Samlesbury Engineering, Ltd.
Vosper, Ltd.

CARBURATION EQUIPMENT
Hobson, Ltd., H. M.
Mills, Ltd., William

CASTINGS, LIGHT ALLOY
Aircraft Materials, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Birmingham Aluminium Casting (1903) Co., Ltd.
Hadfields, Ltd.
Hepworth and Grandage, Ltd.
High Duty Alloys, Ltd.
Napier and Son, Ltd., D.
Preformations, Ltd.
Sankey-Telcon, Ltd.
Sheffield Smelting Co., Ltd., The
Sparklets, Ltd.
Sterling Metals, Ltd.
Stone and Co. (Charlton), Ltd., J.
Vosper, Ltd.
Wellworthy, Ltd.

CASTINGS, STEEL
Brown Bayley Steels, Ltd.
de Havilland Engine Co., Ltd., The
English Steel Castings Corporation, Ltd.
Fairey Aviation, Ltd.
Firth and John Brown, Ltd., Thos.
Firth-Vickers Stainless Steels, Ltd.
Hadfields, Ltd.
Jessop-Saville, Ltd.
Low Moor Alloy Steelworks, Ltd.
Napier and Son, Ltd., D.
Preformations, Ltd.
Sankey-Telcon, Ltd.

CASTINGS, OTHER THAN ABOVE
Birkett, Billington and Newton, Ltd., T. M.
de Havilland Engine Co., Ltd., The
Ferranti, Ltd.
Hepworth and Grandage, Ltd.
Kent Alloys, Ltd.
Napier and Son, Ltd., D.
Salter and Co., Ltd., Geo.
Sankey-Telcon, Ltd.
Stone and Co. (Charlton), Ltd., J.
Tungum Co., Ltd., The
Vosper, Ltd.
Wayne Kerr Laboratories, Ltd., The
Yorkshire Engineering Supplies, Ltd.

ANCILLARY INDUSTRY 1959...

CASTORS
Autoset (Production), Ltd.
Flexello Castors and Wheels, Ltd.

CATERING EQUIPMENT, AIRLINER
Aerogalley
Aircraft Materials, Ltd.
Airport Restaurants, Ltd.
Attewell and Sons, Ltd., B.
Delaney Gallay, Ltd.
Field Aircraft Services, Ltd.
General Electric Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Mallinson and Sons, Ltd., William
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Sparklets, Ltd.

CATERING SERVICES
Airport Restaurants, Ltd.
General Electric Co., Ltd., The

CERAMICS AND CERAMIC COATINGS
Brush Crystal Co., Ltd., The
Lodge Plugs, Ltd.
Plessey Co., Ltd., The
Steatite and Porcelain Products, Ltd.

CHAINS, DRIVING
Renold Chains, Ltd.

CHEMICALS, INDUSTRIAL
Albright and Wilson (Mfg.), Ltd.
Brent Chemical Products, Ltd.
Imperial Chemical Industries, Ltd.
Laporte Chemicals, Ltd.
Valay Industries, Ltd.

CLAMPS, MACHINE-TOOL AND SPECIAL-PURPOSE
Autoset (Production), Ltd.
B.R.D. Co., Ltd.
Bell's Asbestos and Engineering, Ltd.
C.J.C. Developments (Portsmouth), Ltd.
King Aircraft Corporation
Morfax, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Samlesbury Engineering, Ltd.
Skyhi, Ltd.
Woodside Die Sinking Co., Ltd.

CLEANERS, VACUUM
General Electric Co., Ltd., The

CLEANING MATERIALS AND EQUIPMENT
Brent Chemical Products, Ltd.
Laporte Chemicals, Ltd.
Pyrene Co., Ltd., The
Savage, Ltd., W. Bryan
Simon Engineering (Midlands), Ltd.
Valay Industries, Ltd.

CLIPS
Aircraft Materials, Ltd.
Avica Equipment, Ltd.
Brown Bros. (Aircraft), Ltd.
Dunlop Rubber Co., Ltd.
Hellermann, Ltd.
King Aircraft Corporation
Palmer Aero Products, Ltd.
Robinson and Co. (Gillingham), Ltd.
Salter and Co., Ltd., Geo.
Simmonds Aerocessories, Ltd.
Terry and Sons, Ltd., Herbert

CLOCKS
Davall and Sons, Ltd., S.
Graseby Instruments, Ltd.
Smiths Aviation Division

CLOTH, UPHOLSTERY
Bell's Asbestos and Engineering, Ltd.
Fothergill and Harvey, Ltd.
I.C.I. (Hyde), Ltd.
Williamson and Son, Ltd., Jas.

CLOTHING, FLYING
Aerocontacts (Sales), Ltd.
Anticoustic Co., The
Dunlop Rubber Co., Ltd.
Flint, Ltd., Howard
Frankenstein and Sons (Manchester), Ltd., P.
G.Q. Parachute Co., Ltd.
Irving Air Chute of Great Britain, Ltd.
Lewis, Ltd., D.
Siebe, Gorman and Co., Ltd.

CLOTHING, INDUSTRIAL AND PROTECTIVE
Bell's Asbestos and Engineering, Ltd.
Flint, Ltd., Howard
Frankenstein and Sons (Manchester), Ltd., P.
G.Q. Parachute Co., Ltd.
I.C.I. (Hyde), Ltd.
Siebe, Gorman and Co., Ltd.
Turner Bros. Asbestos Co., Ltd.

CLOTHING, UNIFORM
Fishers
Flint, Ltd., Howard

COLD-ROLLED SECTIONS (see also Alloys)
Firth and John Brown, Ltd., Thos.
Imperial Chemical Industries, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The

COMMUNICATION SYSTEMS, AIRCRAFT INTERIOR
Brooklands Aviation, Ltd.
Burndept, Ltd.
Ericsson Telephones, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Murphy Radio, Ltd. (Electronics Division)
Page Engineering (Sunbury on Thames), Ltd.
Standard Telephones and Cables, Ltd.
Ultra Electric, Ltd.
Trix Electrical Co., Ltd., The
W.S. Electronics

COMPONENTS, AIRFRAME (see also Assemblies, Major Airframe)
Aero Controls, Ltd.
Aerocontacts (Aircraft Distributors), Ltd.
Aviation Traders (Engineering), Ltd.
Boulton Paul Aircraft, Ltd.
Brooklands Aviation, Ltd.
Brown Bros. (Aircraft), Ltd.
Brown, Ltd., S. G.
CJC Developments (Portsmouth), Ltd.
Chinn and Co., Ltd., J. S.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
Cramic Aircraft Components, Ltd.
English Electric Aviation, Ltd.
Erith Engineering (Leicester), Ltd.
Fairey Marine, Ltd.
Field Aircraft Services, Ltd.
Gloster Aircraft Co., Ltd.
Goulder and Sons, Ltd., J.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Miles, Ltd., F. G.
Morfax, Ltd.
Parnall and Co., Ltd., George
Parsons, Ltd., J. R.
Philips Electrical, Ltd.
Plessey Co., Ltd., The
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Saunders-Roe, Ltd.
Scottish Aviation, Ltd.
Tiltman Langley, Ltd.
Turner Manufacturing Co., Ltd.
Western Manufacturing (Reading), Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.

COMPONENTS AND DETAILS, ELECTRICAL
Amphenol (Great Britain), Ltd.
Avica Equipment, Ltd.
Belling and Lee, Ltd.
Bosch, Ltd.
British Thomson-Houston Co., Ltd., The
Brown Bros. (Aircraft), Ltd.
Brown, Ltd., S. G.
CJC Developments (Portsmouth), Ltd.
C.W.C. Equipment, Ltd.
C. and N. (Electrical), Ltd.
Davall and Sons, Ltd., S.
Eastern Aero Electrical Services, Ltd.
Electro-Hydraulics, Ltd.
Electro Mechanisms, Ltd.
English Electric Co., Ltd., The
Ericsson Telephones, Ltd.
Erith Engineering (Leicester), Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Graviner Colnbrook
Grundy and Partners, Ltd.
Hendrey Relays, Ltd.
M.B. Metals, Ltd.
Miles, Ltd., F. G.
Page Engineering (Sunbury on Thames), Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Pullin and Co., Ltd., R. B.
Redwing, Ltd.
Rotax, Ltd.
Rotol, Ltd.
Savage, Ltd., W. Bryan
Scottish Aviation, Ltd.
Sheffield Smelting Co., Ltd., The
Smart and Brown (Machine Tools), Ltd.
Somers, Ltd., J. N.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Tiltman Langley, Ltd.
Ward, Brooke and Co., Ltd.
Wayne Kerr Laboratories, Ltd., The
Western Manufacturing (Reading), Ltd.
Williamson Manufacturing Co., Ltd.
Woodside Die Sinking Co., Ltd.

COMPONENTS AND DETAILS, ELECTRONIC
Airmed, Ltd.
Amphenol (Great Britain), Ltd.
Amplivox, Ltd.
Belling and Lee, Ltd.
British Thomson-Houston Co., Ltd., The
Brown Bros. (Aircraft), Ltd.
C. and N. (Electrical), Ltd.
Cathodeon Crystals, Ltd.
Cole, Ltd., E. K.
Connor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Electro Mechanisms, Ltd.
English Electric Co. Ltd., The
Ericsson Telephones, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
Firth Cleveland Instruments, Ltd.
General Electric Co., Ltd., The
Girdlestone Pumps, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Graviner Colnbrook
Grundy and Partners, Ltd.
Hunting Engineering, Ltd.
Integral, Ltd.
Lancefield Aircraft Components, Ltd.
M.B. Metals, Ltd.
Microcell, Ltd.
Miles Electronics, Ltd.
Mullard, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Pullin and Co., Ltd., R. B.
R.F.D. Co., Ltd.
Racal Engineering, Ltd.
Sanders (Electronics), Ltd., W. H.
Saunders-Roe, Ltd.
Savage, Ltd., W. Bryan
Sciaky Electric Welding Machines, Ltd.
Sheffield Smelting Co., Ltd., The
Short Bros. and Harland, Ltd.
Smart and Brown (Machine Tools), Ltd.
Somers, Ltd., J. N.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Texas Instruments, Ltd.
Thorn Electrical Industries, Ltd.
Wayne Kerr Laboratories, Ltd., The
Woodside Die Sinking Co., Ltd.

COMPONENTS, ENGINE, GENERAL
Aero Controls, Ltd.
Aerocontacts (Aircraft Distributors), Ltd.
B.R.D. Co., Ltd.
Birkett, Billington and Newton, Ltd. T. M.
Brown Bros. (Aircraft), Ltd.
Brown, Ltd., S. G.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Goulder and Sons, Ltd., J.
Hercules Engineering Co., Ltd., The
Kelston Engineering Co., Ltd.
King Aircraft Corporation, Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Quality Bearings, Ltd.
Samlesbury Engineering, Ltd.
Turner Manufacturing Co., Ltd.
Vickers-Armstrongs (Aircraft), Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.
Yorkshire Engineering Supplies, Ltd.

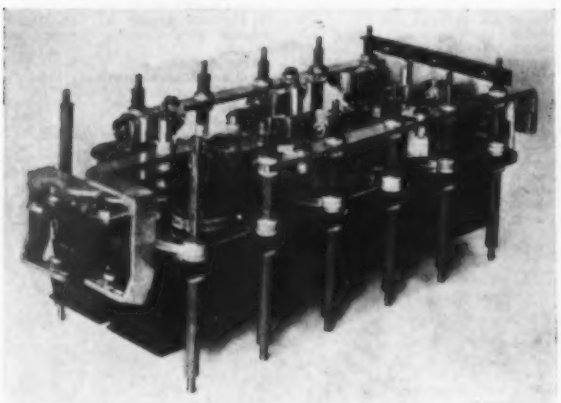
COMPONENTS, GAS-TURBINE SHEET METAL
B.R.D. Co., Ltd.
Bramah and Co., Ltd., J. R.
British Refrasil Co., Ltd., The
Burnley Aircraft Products, Ltd.
Chinn and Co., Ltd., J. S.
Clifford Products, Ltd.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Henderson Safety Tank Co., Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
Marston Excelsior, Ltd.
Morfax, Ltd.
Samlesbury Engineering, Ltd.
Sankey and Sons, Ltd., Joseph
Wilmot Breeden, Ltd.

COMPRESSORS, INDUSTRIAL
Atlas Copco (Great Britain), Ltd.
British Thomson-Houston Co., Ltd., The
de Havilland Engine Co., Ltd., The
Dowty Nucleonics, Ltd.
Godfrey and Partners, Ltd., Sir George
Headland Engineering Developments, Ltd.
Plannair, Ltd.
Rotol, Ltd.
Rubery Owen and Co., Ltd.
Siebe, Gorman and Co., Ltd.
Turner Manufacuring Co., Ltd.
Williams and James (Engineers), Ltd.

CONNECTORS, ELECTRICAL
Amphenol (Great Britain), Ltd.
Belling and Lee, Ltd.
British Insulated Callender's Cables, Ltd.
Burndept, Ltd.
C.W.C. Equipment, Ltd.
Ferranti Meters, Ltd., Denis
Flight Refueling, Ltd.
Girdlestone Pumps, Ltd.

Continued on page v

B.T.H. high-energy ignition unit, Type C10TS



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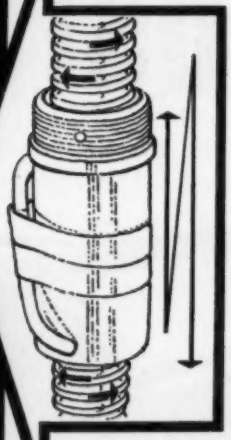

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- Floor loading—300 lbs. per sq. ft. • Passengers—up to 183
- Span—142 ft. • Length—138 ft. • Cabin length—98 ft.
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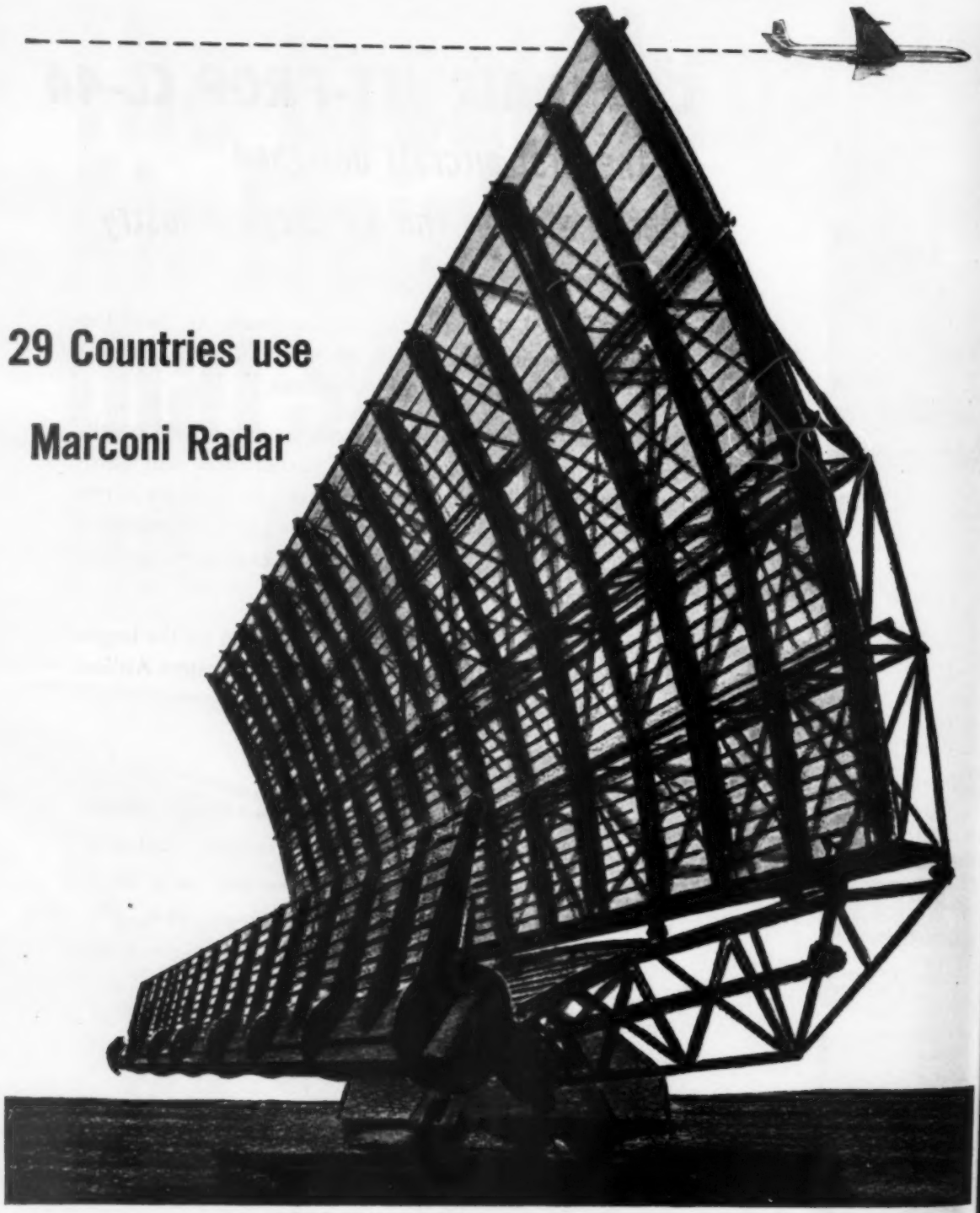
CA59-CL44-1A

Marconi in Radar



29 Countries use

Marconi Radar

MARCONI COMPLETE CIVIL AND MILITARY RADAR INSTALLATIONS

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ANCILLARY INDUSTRY 1959...

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Page Engineering (Sunbury on Thames), Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rist's Wires and Cables, Ltd.
Siemens Edison Swan, Ltd.
Smart and Brown (Machine Tools), Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Vosper, Ltd.
Ward, Brooke and Co., Ltd.
Waymouth Gauges and Instruments, Ltd.

CONNECTORS, HOSE

Aircraft Materials, Ltd.
Avica Equipment, Ltd.
Bell's Asbestos and Engineering, Ltd.
Dunlop Rubber Co., Ltd.
Exactor, Ltd.
Flight Refuelling, Ltd.
Gloster Technical Developments Division
HML (Engineering), Ltd.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
King Aircraft Corporation
Lockheed Precision Products, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Power Auxiliaries, Ltd.
Rollason Aerocessories, Ltd.
Super Oil Seals and Gaskets, Ltd.

CONSULTANT SERVICES

Aircraft and General Finance Corporation, Ltd.
Aviation and Engineering Projects, Ltd.
Aviation Traders (Engineering), Ltd.
Dundas, Ltd., R. K.
Electro Mechanisms, Ltd.
Export Packing Service, Ltd.
Gloster Technical Developments Division
Graviner Colnbrook
Hunting Aerosurveys, Ltd.
International Aeradio, Ltd.
King Aircraft Corporation
Miles, Ltd., F. G.
Miles Electronics, Ltd.
Newmark, Ltd., Louis
Samlesbury Engineering, Ltd.
Scottish Aviation, Ltd.
Solartron Electronic Group, Ltd., The
Texas Instruments, Ltd.
Wynstruments, Ltd.

CONTROL EQUIPMENT, REMOTE

Aero Controls, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Dowty Equipment, Ltd.
Dowty Nucleonics, Ltd.
Electro-Hydraulics, Ltd.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
Hercules Engineering Co., Ltd., The
Hobson, Ltd., H. M.
Honeywell Controls, Ltd.
Mollart Engineering Co., Ltd., The
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Rotol, Ltd.
Savage, Ltd., W. Bryan
Sciaky Electric Welding Machines, Ltd.
Short Bros. and Harland, Ltd.
Solartron Electronic Group, Ltd., The
Standard Telephones and Cables, Ltd.
Teleflex Products, Ltd.
Turner Manufacturing Co., Ltd.
W. S. Electronics
Weyburn Engineering Co., Ltd., The
Wilmot Breeden, Ltd.

CONTROL EQUIPMENT, HELICOPTER

Newmark, Ltd., Louis

Ferranti Pegasus common-language data - processing system: Pegasus 2 with magnetic tapes, high-speed paper tape input/output and battery of printers

CONTROLS, AUTOMATIC (GOVERNORS, ETC.)

Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Gloster Technical Developments Division
Hobson, Ltd., H. M.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Measuring Instruments (Pullin), Ltd.
Plessey Co., Ltd., The
Rotol, Ltd.
Sanders (Electronics), Ltd., W. H.
Short Bros. and Harland, Ltd.
Stone and Co. (Deptford), Ltd., J.
Teddington Aircraft Controls, Ltd.
Venner, Ltd.
Weyburn Engineering Co., Ltd., The

CONTROLS, ENGINE

Amal, Ltd.
Brown, Ltd., S. G.
Davall and Sons, Ltd., S.
Fairey Aviation, Ltd.
Hercules Engineering Co., Ltd., The
Hobson, Ltd., H. M.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Mollart Engineering Co., Ltd., The
Negretti and Zambra, Ltd.
Plessey Co., Ltd., The
Teleflex Products, Ltd.
Ultra Electric, Ltd.
Venner, Ltd.

CONTROLS, FLYING

Aero Controls, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Gloster Technical Developments Division
Lockheed Precision Products, Ltd.
Miles, Ltd., F. G.
Mollart Engineering Co., Ltd., The
Rotax, Ltd.
Rotol, Ltd.
Teleflex Products, Ltd.
Turner Manufacturing Co., Ltd.

CONTROLS, POWERED

Boulton Paul Aircraft, Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Hobson, Ltd., H. M.
Lockheed Precision Products, Ltd.
Savage, Ltd., W. Bryan
Sperry Gyroscope Co., Ltd.
Turner Manufacturing Co., Ltd.

COOLANTS

Imperial Chemical Industries, Ltd.
Mining and Chemical Products, Ltd.

COPPER

Aircraft Materials, Ltd.
Booth and Co., Ltd., James
British Insulated Callender's Cables, Ltd.
Imperial Chemical Industries, Ltd.
Kaye, Ltd., E. and E.
Rollet and Co., Ltd., H.
Stone and Co. (Charlton), Ltd. J.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

CORROSION INHIBITORS AND EQUIPMENT

B. B. Chemical Co., Ltd.
Brand and Co., Ltd., R. A.
Brent Chemical Products, Ltd.
Docker Bros.
Hellermann, Ltd.
Imperial Chemical Industries, Ltd.
Miles Structural Plastics, Ltd.
Pyrene Co., Ltd., The
Skyhi, Ltd.
Stuart (London), Ltd., Robert
Valay Industries, Ltd.
Wakefield and Co., Ltd., C. C.
Wakefield-Dick Industrial Oils, Ltd.

COUNTING EQUIPMENT

Davall and Sons, Ltd., S.
Ericsson Telephones, Ltd.
Ferranti Meters, Ltd., Denis
Gloster Technical Developments Division
Plessey Co., Ltd., The
Wynstruments, Ltd.

COUPLINGS, FLEXIBLE (see also Joints, universal)

Aero Controls, Ltd.
Avica Equipment, Ltd.
Avimo, Ltd.
B. R. D. Co., Ltd.
Bell's Asbestos and Engineering, Ltd.
Boorn and Co., Ltd., Thomas
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Flight Refuelling, Ltd.
Gloster Technical Developments Division
Hardy Spicer, Ltd.
High-Pressure Components, Ltd.
King Aircraft Corporation
Lockheed Precision Products, Ltd.
Mollart Engineering Co., Ltd., The
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Renold Chains, Ltd.

COUPLINGS, SELF-SEALING

Aero Controls, Ltd.
Avery-Hardoll, Ltd.
Avica Equipment, Ltd.
Avimo, Ltd.
Brown Bros. (Aircraft), Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
HML (Engineering), Ltd.
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
King Aircraft Corporation, Ltd.
Lockheed Precision Products, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Palmer Aero Products, Ltd.

COVERS, AIRCRAFT, ETC.

Brand and Co., Ltd., R. A.
Fireproof Tanks, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
I. C. I. (Hyde), Ltd.
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
Latex Upholstery, Ltd.
R. F. D. Co., Ltd.
Scottish Aviation, Ltd.

DAMPERS, CONTROL

Electro-Hydraulics, Ltd.
Girling, Ltd.
Gloster Technical Developments Division

DAMPERS, GENERAL MOTION

Electro-Hydraulics, Ltd.
Girling, Ltd.

DATA-PROCESSING EQUIPMENT

Air Trainers Link, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Blackburn Electronics, Ltd.
Bristol Aircraft, Ltd.
British Thomson-Houston Co., Ltd., The
Bryans Aeroquipment, Ltd.
Decca Radar, Ltd.
de Havilland Propellers, Ltd.
Dobbie McInnes (Electronics), Ltd.
E. M. I. Electronics, Ltd.
English Electric Aviation, Ltd.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Gloster Technical Developments Division
Honeywell Controls, Ltd.
Integral, Ltd.
Kelvin and Hughes (Aviation), Ltd.
Microcell, Ltd.
Miles Electronics, Ltd.
Mullard Equipment, Ltd.
Newmark, Ltd., Louis
Plessey Co., Ltd., The
Saunders-Roe, Ltd.
SFIM (Great Britain), Ltd.
Short Bros. and Harland, Ltd.
Solartron Electronic Group, Ltd., The
Southern Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Ultra Electric, Ltd.

DECARBONIZING PREPARATIONS AND EQUIPMENT

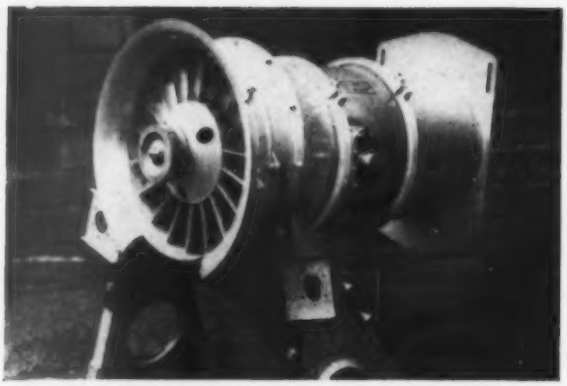
Bennett (Hyde), Ltd.
Brent Chemical Products, Ltd.

DEGREASING PREPARATIONS AND EQUIPMENT

Bennett (Hyde), Ltd.
Brent Chemical Products, Ltd.
Brown Bros. (Aircraft), Ltd.
Docker Bros.
Imperial Chemical Industries, Ltd.
Laporte Chemicals, Ltd.
Morfax, Ltd.
Pyrene Co., Ltd., The
Valay Industries, Ltd.
Wakefield and Co., Ltd., C. C.
Wakefield-Dick Industrial Oils, Ltd.

DE-ICING AND ANTI-ICING EQUIPMENT AND FLUIDS, ETC.

Aerocontacts (Aircraft Distributors), Ltd.
Bell's Asbestos and Engineering, Ltd.
Davall and Sons, Ltd., S.
Delaney Gallay, Ltd.
Dragonair, Ltd.
Dunlop Rubber Co., Ltd.
Edghill and Co., Ltd., H. W.
Flexible Ducting, Ltd.
Gloster Technical Developments Division
Godden (Cheltenham), Ltd., M. H.
Heckford, Ltd., Arthur E.
Hercules Engineering Co., Ltd., The
Hunting Mhoglas, Ltd.
Imperial Chemical Industries, Ltd.
Isopad, Ltd.
Kenilworth Manufacturing Co., Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Manchester Oil Refinery (Sales), Ltd.
Metachemical Processes, Ltd.
Napier and Son, Ltd., D.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rollason Aerocessories, Ltd.
Rotax, Ltd.
Sangamo Weston, Ltd.
Shell-Mex and BP, Ltd.
Simon Engineering (Midlands), Ltd.
Technograph Electronic Products, Ltd.
Teddington Aircraft Controls, Ltd.



Gearbox cooling installation and engine oil cooler for Westland Wessex (Serck Radiators, Ltd.)

ANCILLARY INDUSTRY 1959...

DESIGN AND EXPERIMENTAL WORK
(see also Drawing Office Services)

Abbey Panel and Sheet Metal Co., Ltd.
Aero Controls, Ltd.
Agricultural Aviation Co., Ltd.
Aircraft Materials, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation and Engineering Projects, Ltd.
Aviation Traders (Engineering), Ltd.
B. R. D. Co., Ltd.
Bell Precision Engineering Co., Ltd.
Boulton Paul Aircraft, Ltd.
British Oxygen Gases, Ltd.
Brown, Ltd., S. G.
CJC Developments (Portsmouth), Ltd.
C. and N. (Electrical), Ltd.
Chinn and Co., Ltd., J. S.
Cornercroft, Ltd.
Cossor Radar and Electronics, Ltd.
Cross Manufacturing Co. (1938), Ltd.
Davall and Sons, Ltd., S.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
E. P. S. (Research and Development), Ltd.
Eagle Aircraft Services, Ltd.
Electro-Hydraulics, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
English Electric Co., Ltd., The
Ericsson Telephones, Ltd.
Erith Engineering (Leicester), Ltd.
Farranti Meters, Ltd., Denis
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gordon and Co.
Graseby Instruments, Ltd.
Henderson Safety Tank Co., Ltd.
Hendrey Relays, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Hunting Aerosurveys, Ltd.
Hymatic Engineering Co., Ltd., The
Irving Air Chute of Great Britain, Ltd.
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
M. B. Metals, Ltd.
M. L. Aviation Co., Ltd.
Mechanism, Ltd.
Mercury Airfield Equipment, Ltd.
Miles, Ltd., F. G.
Miles Electronics, Ltd.
Miles Structural Plastics, Ltd.
Morfax, Ltd.
Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Palmer Aero Products, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Portsmouth Aviation, Ltd.
R. F. D. Co., Ltd.
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Sanders (Electronics), Ltd., W. H.
Saunders-Roe, Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
Texas Instruments, Ltd.
Tiltman Langley, Ltd.
Villiers (Tool Developments), Ltd.
Vosper, Ltd.
W. S. Electronics
Ward, Brooke and Co., Ltd.
Western Mfg. (Reading), Ltd.
Williamson Manufacturing Co., Ltd.
Woodside Die Sinking Co., Ltd.
Wynstruments, Ltd.

DIALS, INSTRUMENT

Ericsson Telephones, Ltd.
Field Aircraft Services, Ltd.
Mechanism, Ltd.
Miles Electronics, Ltd.
Salford Electrical Instruments, Ltd.
Turner Electrical Instruments, Ltd., Ernest

DIAMONDS AND DIAMOND TOOLS

Van Moppes and Sons (Diamond Tools), Ltd., L. M.

DIAPHRAGMS

Appleby and Ireland, Ltd.
Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Davall and Sons, Ltd., S.
Dunlop Rubber Co., Ltd.
Fireproof Tanks, Ltd.
Hall and Hall, Ltd.
Long and Hambly, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Mechanism, Ltd.
Munro, Ltd., R. W.
Negretti and Zambra, Ltd.
Northern Rubber Co., Ltd., The
Precision Rubbers, Ltd.
Samlesbury Engineering, Ltd.
Short and Mason, Ltd.
Trist and Co., Ltd., Ronald

DINGHIES

Beaufort (Air Sea) Equipment, Ltd.
Elliot Equipment, Ltd.
Fairey Marine, Ltd.
Frankenstein and Sons (Manchester), Ltd., P.
Palmer Aero Products, Ltd.
R. F. D. Co., Ltd.
Ward, Brooke and Co., Ltd.

DOCKS, AIRCRAFT MAINTENANCE

Aero Controls, Ltd.
Aviation Traders (Engineering), Ltd.
Gordon and Co.
Morfax, Ltd.
Tiltman Langley, Ltd.

DOORS, FOLDING, SLIDING, ETC.
(see also Shutters)

Bolton Gate Co., Ltd.
Booth and Sons (Bolton), Ltd., John
Esavian, Ltd.
Hercules Engineering Co., Ltd., The
Morfax, Ltd.
Parnall and Co., Ltd., George
Templewood Hawksley, Ltd.

DOPPLER NAVIGATION AIDS

Cole, Ltd., E. K.
Ekco Electronics, Ltd.
Graseby Instruments, Ltd.
Marconi's Wireless Telegraph Co., Ltd.

DRAWING OFFICE EQUIPMENT

Samlesbury Engineering, Ltd.
Technical Publications and Supplies, Ltd.

DRAWING OFFICE SERVICES
(see also Design and Experimental

Aero Controls, Ltd.
Aviation and Engineering Projects, Ltd.
Aviation Traders (Engineering), Ltd.
B. R. D. Co., Ltd.
Bell Precision Engineering, Ltd.
Davall and Sons, Ltd., S.
Export Packing Service, Ltd.
Farranti Meters, Ltd., Denis
Field Aircraft Services, Ltd.
Gloster Aircraft Co., Ltd.
Gordon and Co.
King Aircraft Corporation
Miles, Ltd., F. G.
Miles Electronics, Ltd.
Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Saunders-Roe, Ltd.
Scotney, Ltd., Tom M.
Scottish Aviation, Ltd.
Skyways, Ltd.
Technical Platings, Ltd.
Tiltman Langley, Ltd.
Villiers (Tool Developments), Ltd.
W. S. Electronics, Ltd.
Woodside Die Sinking Co., Ltd.

EAR DEFENDERS

Amplivox, Ltd.
Anticoustic Co., The
Ferranti Meters, Ltd., Denis
Siebe, Gorman and Co., Ltd.
Sutton (Consultants), Ltd., R. W.

EDUCATION, TECHNICAL
(other than apprenticeships)

Marconi's Wireless Telegraph Co., Ltd.
Sanders (Electronics), Ltd., W. H.

ELECTRICAL EQUIPMENT, GENERAL
(see also under Components)

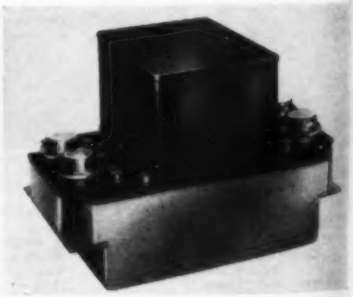
Bosch, Ltd.
British Insulated Callender's Cables, Ltd.
British Thomson-Houston Co., Ltd., The
Brown, Ltd., S. G.
Burndept, Ltd.
C. and N. (Electrical), Ltd.
Cossor Instruments, Ltd.
Electro-Hydraulics, Ltd.
English Electric Co., Ltd., The
Fairey Aviation, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Graseby Instruments, Ltd.
M.B. Metals, Ltd.
M.L. Aviation Co., Ltd.
Miles, Ltd., F. G.
Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Sheffield Smelting Co., Ltd., The
Smart and Brown (Machine Tools), Ltd.
Somers, Ltd., J. N.
SPE Co., Ltd.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Vernons Industries, Ltd.
Vosper, Ltd.
W.S. Electronics
Ward, Brooke and Co., Ltd.
Wayne Kerr Laboratories, Ltd., The
Western Manufacturing (Reading), Ltd.
Z and I Aero Services, Ltd.

ELECTRONIC EQUIPMENT, GENERAL
(see also under Components)

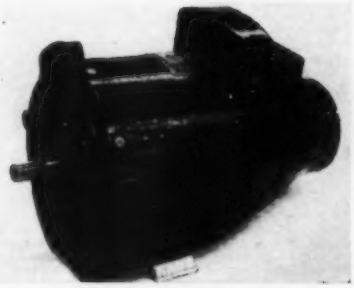
Air Trainers Link, Ltd.
Amphenol (Great Britain), Ltd.
Anticoustic Co., The
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Blackburn Electronics, Ltd.
Boulton Paul Aircraft, Ltd.
Bradley, Ltd., G. and E.
Bristol Aircraft, Ltd.
British Thomson-Houston Co., Ltd., The
Burndept, Ltd.
Cole, Ltd., E. K.
C. and N. (Electrical), Ltd.
Cossor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
E. M. I. Electronics, Ltd.
Ekco Electronics, Ltd.
English Electric Co., Ltd., The
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Gloster Aircraft Co., Ltd.
Goodmans Industries, Ltd.
Graseby Instruments, Ltd.
Hunting Engineering, Ltd.
Integral, Ltd.
International Aeradio, Ltd.
M. B. Metals, Ltd.
M. L. Aviation Co., Ltd.
McMichael Radio, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Microcell, Ltd.
Miles Electronics, Ltd.
Mullard Equipment, Ltd.
Murphy Radio, Ltd. (Electronics Division)

A lightweight high-attenuation headset with "fluid-foam" sound seal and boom-type microphone (The Anticoustic Co.)

Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Racal Engineering, Ltd.
Sanders (Electronics), Ltd., W. H.
Saunders-Roe, Ltd.
Savage, Ltd., W. Bryan
Sheffield Smelting Co., Ltd., The
Short Bros. and Harland, Ltd.
Smart and Brown (Machine Tools), Ltd.
Solartron Electronic Group, Ltd., The
Somers, Ltd., J. N.
Southern Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Ultra Electric, Ltd.
W. S. Electronics
Wayne Kerr Laboratories, Ltd., The
Wynstruments, Ltd.
Z and I Aero Services, Ltd.



Aircraft transistor power convertor unit by Ultra Electric, Ltd., Special Products Division



Rotax brushless alternator, 40kVA

ENGINE COMPONENTS, GENERAL (gas turbines)
Aero Controls, Ltd.
B.R.D. Co., Ltd.
Brown Bros. (Aircraft), Ltd.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Dunlop Rubber Co., Ltd.
Firth-Derihon Stampings, Ltd., The
Goulder and Sons, Ltd., J.
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Morfax, Ltd.
Plessey Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Samlesbury Engineering, Ltd.
Sankey and Sons, Ltd., Joseph
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.
Yorkshire Engineering Supplies, Ltd.

ENGINE COMPONENTS, GENERAL (piston engines)
B.R.D. Co., Ltd.
Brown Bros. (Aircraft), Ltd.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Goulder and Sons, Ltd., J.
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Plessey Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Samlesbury Engineering, Ltd.
Turner Manufacturing Co., Ltd.
Weyburn Engineering Co., Ltd., The
Woodside Die Sinking Co., Ltd.
Yorkshire Engineering Supplies, Ltd.

ENGINE STARTERS AND STARTING EQUIPMENT (see also Ground power units)
Atlas Copco (Great Britain), Ltd.
Auto Diesels, Ltd.
Blackburn Engines, Ltd.
Brown Construction Equipment, Ltd., David
Duvall and Sons, Ltd., S.
Folland Aircraft, Ltd.
Gloster Technical Developments Division
HML (Engineering), Ltd.
Headland Engineering Developments, Ltd.
Hercules Engineering Co., Ltd., The
Houchin, Ltd.
Kigass, Ltd.
Petbow, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Rover Gas Turbines, Ltd.
Standard Telephones and Cables, Ltd.
Venner Accumulators, Ltd.
Vernons Industries, Ltd.
Westinghouse Brake and Signal Co., Ltd.

EXPANDED MATERIALS (other than plastics and rubber)
Palmer Aero Products, Ltd.

EXPERIMENTAL WORK—see Design

EXTRUSIONS, LIGHT ALLOY
Birmetals, Ltd.
Booth and Co., Ltd., James
High Duty Alloys, Ltd.
Imperial Chemical Industries, Ltd.
Kaye, Ltd., E. and E.
Northern Aluminium Co., Ltd.
Rollet and Co., Ltd., H.
Southern Forge, Ltd.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

EXTRUSIONS, STEEL
Low Moor Alloy Steelworks, Ltd.
Low Moor Fine Steels, Ltd.
Reynolds Tube Co., Ltd.

FABRIC, AIRFRAME
Aircraft Materials, Ltd.
Brown Bros. (Aircraft), Ltd.

FABRIC, CABIN FURNISHING
Fothergill and Harvey, Ltd.
Latex Upholstery, Ltd.
Mallinson and Sons, Ltd., William
Rumbold and Co., Ltd., L. A.
Samlesbury Engineering, Ltd.
Scottish Aviation, Ltd.
Williamson and Son, Ltd., Jas.

FABRICATIONS, SHEET METAL
Abbey Panel and Sheet Metal Co., Ltd.
Aero Controls, Ltd.
Aircraft Materials, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
Bell Precision Engineering, Ltd.
Bramah and Co., Ltd., J. R.
Bristol Aerojet, Ltd.
British Refrasil Co., Ltd., The
Burnley Aircraft Products, Ltd.
Chinn and Co., Ltd., J. S.
Clifford Products, Ltd.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Fairey Aviation, Ltd.
Field Aircraft Services, Ltd.
Gordon and Co.
Grundy and Partners, Ltd.
Harvey and Co. (London), Ltd., G. A.
Henderson Safety Tank Co., Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Jablo Propellers, Ltd.
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Miles, Ltd., F. G.
Morfax, Ltd.
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Redwing, Ltd.
Rollason Aerocessories, Ltd.
Samlesbury Engineering, Ltd.
Sankey and Sons, Ltd., Joseph
Saunders-Roe (Anglesey), Ltd.
Scottish Aviation, Ltd.
Serck Radiators, Ltd.
Skyways, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Tiltman Langley, Ltd.
Tungum Co., Ltd., The
Vosper, Ltd.
Western Manufacturing (Reading), Ltd.
Wilmot Breeden, Ltd.

FABRICATIONS, TUBULAR
Accles and Pollock, Ltd.
Aero Controls, Ltd.
Aviation Traders (Engineering), Ltd.
Avica Equipment, Ltd.
Bramah and Co., Ltd., J. R.
Burnley Aircraft Products, Ltd.
Delaney Gallay, Ltd.
Gordon and Co.
Henshall and Sons (Addlestone), Ltd.
Lancefield Aircraft Components, Ltd.
Mercury Airfield Equipment, Ltd.
Miles, Ltd., F. G.
Portsmouth Aviation, Ltd.
Reynolds Tube Co., Ltd.
Rollason Aerocessories, Ltd.
Samlesbury Engineering, Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
Talbot Stead Tube Co., Ltd.
Tiltman Langley, Ltd.
Tungum Co., Ltd., The
Western Manufacturing (Reading), Ltd.
Wilmot Breeden, Ltd.

Kane, Ltd., Douglas
King Aircraft Corporation
Oddie, Bradbury and Cull, Ltd.
Palmer Aero Products, Ltd.
Salter and Co., Ltd., Geo.
Simmonds Aerocessories, Ltd.
Unbrako Socket Screw Co., Ltd., The
Wilmot Breeden, Ltd.

FILING EQUIPMENT, DOCUMENT
Harvey and Co. (London), Ltd., G. A.

FILLERS, FOR TUBE BENDING
Mining and Chemical Products, Ltd.
Terry and Sons, Ltd., Herbert

FILTERS, AIR AND GAS
Automotive Products Co., Ltd.
B.M.B. (Sales), Ltd.
Coopers Mechanical Joints, Ltd.
Dunlop Rubber Co., Ltd.
Fairey Aviation, Ltd.
Fibreglass, Ltd.
Hymatic Engineering Co., Ltd., The

Engine oil cooler fan for Napier Gazelle (The Airscrew Co. and Jicwood, Ltd.)

FANS (see also Wind Tunnels and equipment)
Airscrew Co. and Jicwood, Ltd., The
B.M.B. (Sales), Ltd.
English Electric Aviation, Ltd.
General Electric Co., Ltd., The
Godfrey and Partners, Ltd., Sir George
Hercules Engineering Co., Ltd., The
Hordern-Richmond, Ltd.
Marston Excelsior, Ltd.
Plannair, Ltd.

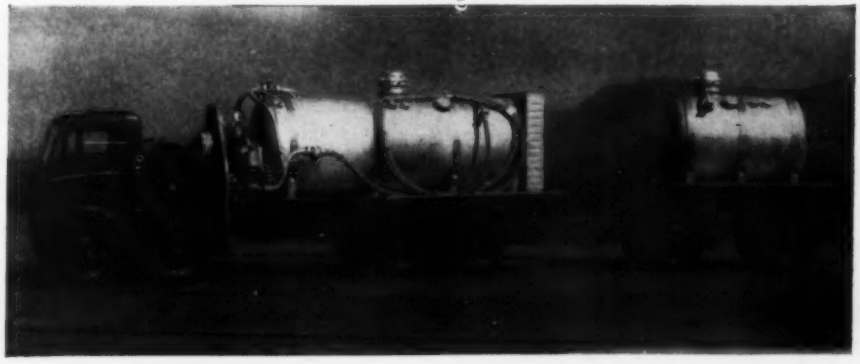
FASTENERS, INCLUDING COWLING AND SPECIAL PURPOSE
Aero Controls, Ltd.
Amal, Ltd.
Aviation Developments, Ltd.
Brown Bros. (Aircraft), Ltd.
Dzus Fastener Europe, Ltd.
Fairey Aviation, Ltd.
Palmer Aero Products, Ltd.
Rellumit (London), Ltd.
Siebe, Gorman and Co., Ltd.
Stream-Line Filters, Ltd.
Thermal Control Co., Ltd.
Vokes, Ltd.
Williams and James (Engineers), Ltd.

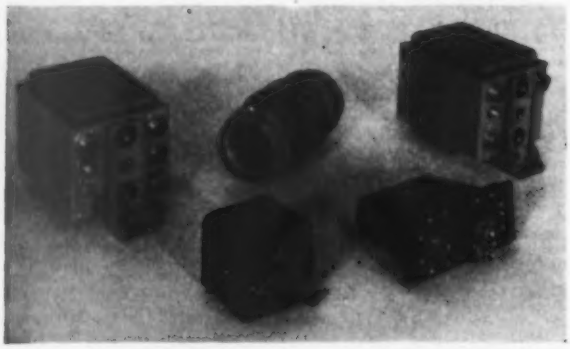
FILTERS, ELECTRICAL
Belling and Lee, Ltd.
Ericsson Telephones, Ltd.
McMichael Radio, Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.

FILTERS, FUEL AND OIL
Amal, Ltd.
Aircraft Materials, Ltd.
Automotive Products Co., Ltd.
Bramah and Co., Ltd., J. R.

Continued overleaf

Tanker and trailer designed and built by Saunders-Roe (Anglesey), Ltd., for the fuelling and transportation of H.T.P. The main tank has a capacity of 1,800 gal and the trailer tank 900 gal. Auxiliary water tanks with a total capacity of over 500 gal are provided and pumping is by a power take-off





Firth Cleveland fuel flowmeter equipment for high performance aircraft

ANCILLARY INDUSTRY 1959...

Coopers Mechanical Joints, Ltd.
Dunlop Rubber Co., Ltd.
Exactor, Ltd.
Fairey Aviation, Ltd.
Fibreglass, Ltd.
Gordon and Co.
Harvey and Co. (London), Ltd., G. A.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Kigass, Ltd.
King Aircraft Corporation
Palmer Aero Products, Ltd.
Philips Electrical, Ltd.
Rellumit (London), Ltd.
Simmonds Aerocessories, Ltd.
Stream-Line Filters, Ltd.
Tecalemit, Ltd.
Thermal Control Co., Ltd.
Vokes, Ltd.
Wayne Tank and Pump Co., Ltd.
Zwicky, Ltd.

FILTERS, OTHER FLUID

Coopers Mechanical Joints, Ltd.
Dunlop Rubber Co., Ltd.
Fairey Aviation, Ltd.
Harvey and Co. (London), Ltd., G. A.
Henshall and Sons (Addlestone), Ltd., W.
King Aircraft Corporation
Palmer Aero Products, Ltd.
Philips Electrical, Ltd.
Rellumit (London), Ltd.
Rotol, Ltd.
Stream-Line Filters, Ltd.
Tecalemit, Ltd.
Thermal Control Co., Ltd.
Vokes, Ltd.
Wayne Tank and Pump Co., Ltd.
Zwicky, Ltd.

FINISHES, AIRCRAFT
(see also Paints)

Cellon, Ltd.
Docker Bros.
Hall and Sons (Bristol and London), Ltd., John
Imperial Chemical Industries, Ltd.
Modern Industrial Finishes, Ltd.
Ryland, Ltd., Llewellyn
Titanine, Ltd.

FIRE FIGHTING AND DETECTION EQUIPMENT, AIRBORNE

Cathodeon, Ltd.
Graviner Colnbrook
Kidde Co., Ltd., The Walter
Pyrene Co., Ltd., The
Scottish Aviation, Ltd.
Short and Mason, Ltd.
Thermal Control Co., Ltd.

FIRE FIGHTING EQUIPMENT, GROUND

Bell's Asbestos and Engineering, Ltd.
Coventry Climax Engines, Ltd.
Flint, Ltd., Howard
General Fire Appliance Co., Ltd., The
Gordon and Co.
Kidde Co., Ltd., The Walter
Pyrene Co., Ltd., The
Rover Gas Turbines, Ltd.
Simon Engineering (Midlands), Ltd.
Transport Equipment (Thornycroft), Ltd.

FLAME TRAPS

Amal, Ltd.
Henshall and Sons (Addlestone), Ltd., W.

FLAW-DETECTION EQUIPMENT AND MATERIALS

Brent Chemical Products, Ltd.
Brush Crystal Co., Ltd., The
Cossor Instruments, Ltd.
Manchester Oil Refinery (Sales), Ltd.
Palmer Aero Products, Ltd.
Sperry Gyroscope Co., Ltd.
Ultra Electric, Ltd.

FLOTATION GEAR

Beaufort (Air Sea) Equipment, Ltd.
Frankenstein and Sons (Manchester), Ltd., P.
Jablo Propellers, Ltd.
Palmer Aero Products, Ltd.
Siebe, Gorman and Co., Ltd.
Ward, Brooke and Co., Ltd.

FLUID, HYDRAULIC

Esso Petroleum Co., Ltd.
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Lockheed Precision Products, Ltd.
Manchester Oil Refinery (Sales), Ltd.
Shell-Mex and BP, Ltd.
Vaughan and Co., Ltd., Edgar
Wakefield and Co., Ltd., C. C.
Wakefield-Dick Industrial Oils, Ltd.

FLUIDS, ETC., INDUSTRIAL
(other than under specific headings)

Imperial Chemical Industries, Ltd.

FORGINGS, DROP

English Electric Aviation, Ltd.
English Steel Forge and Engineering Corporation, Ltd.
Firth-Derihon Stampings, Ltd., The
Garringtons, Ltd.
High Duty Alloys, Ltd.
Hughes-Johnson Stampings, Ltd., The
Omes, Ltd.
Smith's Stamping Works (Coventry), Ltd.
Stone and Co. (Charlton), Ltd., J.

FORGINGS IN HEAT-RESISTING MATERIALS

English Electric Aviation, Ltd.
Firth and John Brown, Ltd., Thos.
Garringtons, Ltd.
Hadfields, Ltd.
Hughes-Johnson Stampings, Ltd., The
Jessop-Saville, Ltd.
Low Moor Alloy Steelworks, Ltd.
Omes, Ltd.
Smith's Stamping Works (Coventry), Ltd.
Titanium Metal and Alloys, Ltd.
Wiggin and Co., Ltd., Henry

FORGINGS, LIGHT ALLOY

Birmetals, Ltd.
Booth and Co., Ltd., James
English Electric Aviation, Ltd.
Hadfields, Ltd.
High Duty Alloys, Ltd.
Hughes-Johnson Stampings, Ltd., The
Northern Aluminium Co., Ltd.
Southern Forge, Ltd.

FORGINGS, STEEL

English Electric Aviation, Ltd.
English Steel Forge and Engineering Corporation, Ltd.
Firth and John Brown, Ltd., Thos.
Firth-Vickers Stainless Steels, Ltd.
Hadfields, Ltd.
High Duty Alloys, Ltd.
Hughes-Johnson Stampings, Ltd., The
Jessop-Saville, Ltd.
Kayser, Ellison and Co., Ltd.
Low Moor Alloy Steelworks, Ltd.
Omes, Ltd
Smith's Stamping Works (Coventry), Ltd.
Steel, Peech and Tozer
Tubes, Ltd.
United Steel Companies, Ltd., The

FORGINGS, OTHER THAN ABOVE

Firth and John Brown, Ltd., Thos.
Jessop-Saville, Ltd.
Omes, Ltd
Stone and Co. (Charlton), Ltd., J.
Telegraph Construction and Maintenance Co., Ltd., The
Tungum Co., Ltd., The
Vosper, Ltd.

FREIGHT EQUIPMENT, AIRBORNE

Aerolex, Ltd.
Aviation Traders (Engineering), Ltd.
King Aircraft Corporation
Rollason Aerocessories, Ltd.
Samlesbury Engineering, Ltd.

FREIGHT HANDLING EQUIPMENT

Aero Controls, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
Edghill and Co., Ltd., H. W.
Electro-Hydraulics, Ltd.
M.L. Aviation Co., Ltd.
Samlesbury Engineering, Ltd.
Tiltman Langley, Ltd.

FRICTION LININGS

Turner Bros. Asbestos Co., Ltd.

FUEL MEASUREMENT AND CALIBRATION EQUIPMENT

Amal, Ltd.
Appleby and Ireland, Ltd.
Avery-Hardoll, Ltd.
Bryans Aeroquipment, Ltd.
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Exactor, Ltd.
Firth Cleveland Instruments, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Integral, Ltd.
Kent, Ltd., George
Lucas (Gas Turbine Equipment), Ltd., Joseph
Morfax, Ltd.
Negretti and Zambra, Ltd.
Palmer Aero Products, Ltd.
Rotol, Ltd
Smiths Aviation Division
Waymouth Gauges and Instruments, Ltd.
Wynstruments, Ltd.

FUEL SYSTEMS, ENGINE

de Havilland Propellers, Ltd.
Dowty Fuel Systems, Ltd.
Hobson, Ltd., H. M.
King Aircraft Corporation
Lucas (Gas Turbine Equipment), Ltd., Joseph
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Pulsometer Engineering Co., Ltd.

FUELLING EQUIPMENT, AIRCRAFT

Avery-Hardoll, Ltd.
Coventry Climax Engines, Ltd.
Edghill and Co., Ltd.
Exactor, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Rellumit (London), Ltd.
Saunders-Roe (Anglesey), Ltd.
Stream-Line Filters, Ltd.
Thompson Bros. (Bilston), Ltd.
Vosper, Ltd.
Wayne Tank and Pump Co., Ltd.
Zwicky, Ltd.

FUELLING EQUIPMENT, ROCKET, ETC

Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Rellumit (London), Ltd.
Saunders-Roe (Anglesey), Ltd.

FUELS, AIRCRAFT

Esso Petroleum Co., Ltd.
Imperial Chemical Industries, Ltd.
Regent Oil Co., Ltd.
Shell-Mex and BP, Ltd.

FUELS, ROCKET, ETC.

British Oxygen Gases, Ltd.
Laporte Chemicals, Ltd.
Shell-Mex and BP, Ltd.

FURNISHING EQUIPMENT, AIRCRAFT

Aerocontacts (Aircraft Distributors), Ltd.
Aircraft Furnishing, Ltd.
Delaney Gallay, Ltd.
Field Aircraft Services, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
Latex Upholstery, Ltd.
Mallinson and Sons, Ltd., William
Miles Structural Plastics, Ltd.
Parnall and Co., Ltd., George
Rumbold and Co., Ltd., L. A.
Samlesbury Engineering, Ltd.
Transport Seating, Ltd.

FUSES

Belling and Lee, Ltd.
Davall and Sons, Ltd., S.
Rotax, Ltd.
Ward, Brooke and Co., Ltd.

Continued on page ix

A Boeing 707 being refuelled by an Esso 6,000 imp gal fueller. Avery-Hardoll equipment on the vehicle includes bottom-loading and bulk meters with slow-close valves, each of 450 imp gal/min capacity

Marconi in the Comet 4

Equipped by Marconi to meet the major radio requirements of a modern airliner

MARCONI

COMPLETE AIRCRAFT AND AIRPORT RADIO SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

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AIRCRAFT ARE FLYING FASTER . . .
RADIO IS BECOMING EVEN MORE IMPORTANT

Amalgamated Wireless (Australasia) Limited has long been the leader in aviation radio in Australasia.

By the manufacture of modern aviation radio, and by its efficient, nationwide servicing organisation, Amalgamated Wireless (Australasia) Limited has contributed to the superlative safety record of Australian airlines.

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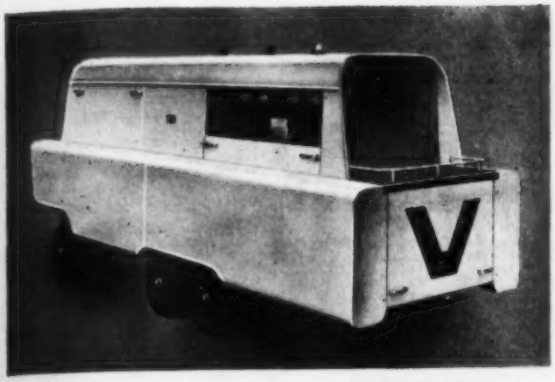
See our display at Stand No. 13 S.B.A.C. Static display.

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED
47 York Street, Sydney, Australia
and at Melbourne, Perth, Brisbane, Wellington, London.



New 60 kVA A.C. ground-power unit by Vernons Industries, Ltd.

ANCILLARY INDUSTRY 1959...

GALLEY EQUIPMENT
Aerogalley
Airport Restaurants, Ltd.
Attewell and Sons, Ltd., B.
Delaney Gallay, Ltd.
Field Aircraft Services, Ltd.
General Electric Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lec Refrigeration, Ltd.
Mallinson and Sons, Ltd., William
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Saunders Valve Co., Ltd.
Tiltman Langley, Ltd.

GASES, LIQUIFIED
British Oxygen Gases, Ltd.
Imperial Chemical Industries, Ltd.
Shell-Mex and BP, Ltd.

GASES, LIQUIFIED, HANDLING EQUIPMENT FOR
British Oxygen Gases, Ltd.
Flight Refuelling, Ltd.
Imperial Chemical Industries, Ltd.
Normalair, Ltd.
Siebe, Gorman and Co., Ltd.

GASKETS
Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Brown Bros. (Aircraft), Ltd.
Coopers Mechanical Joints, Ltd.
Crossley (Packings), Ltd., Henry
Dowty Seals, Ltd.
Dunlop Rubber Co., Ltd.
Fireproof Tanks, Ltd.
Hall and Hall, Ltd.
Kautex, Ltd.
Microcell, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Trist and Co., Ltd., Ronald
Turner Bros. Asbestos Co., Ltd.
Walker and Co., Ltd., James

GAUGES, STRAIN
Davall and Sons, Ltd., S.
Electro Mechanisms, Ltd.
Gloster Technical Developments Division
Plessey Co., Ltd., The
Sangamo Weston, Ltd.
Saunders-Roe, Ltd.
Technograph Electronic Products, Ltd.

GEARS AND GEAR SYSTEMS
Brown, Ltd., S. G.
Davall and Sons, Ltd., S.
de Havilland Engine Co., Ltd., The
E.N.V. Engineering Co., Ltd.
Erith Engineering (Leicester), Ltd.
Gear Grinding Co., Ltd., The
Graseby Instruments, Ltd.
Hercules Engineering Co., Ltd., The
Miles, Ltd., F. G.
Pullin and Co., Ltd., R. B.
Rotol, Ltd.
Vactric (Control Equipment), Ltd.

GENERATORS, ELECTRIC
Auto Diesels, Ltd.
Bosch, Ltd.
British Thomson-Houston Co., Ltd., The
Coventry Climax Engines, Ltd.
de Havilland Propellers, Ltd.
English Electric Co., Ltd., The
General Electric Co., Ltd., The
Ketay, Ltd
Newton Bros. (Derby), Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
SFIM (Great Britain), Ltd.
Vernons Industries, Ltd.

GLASS, SAFETY
Suntex Safety Glass Industries, Ltd.
Triplex Safety Glass Co., Ltd.

GLIDER EQUIPMENT
Irving Air Chute of Great Britain, Ltd.
Normalair, Ltd.
Palmer Aero Products, Ltd.
Pullin and Co., Ltd., R. B.
Turner and Co., Ltd., Luke

GOVERNORS
(see also Controls, automatic)
Cross Manufacturing Co. (1938), Ltd.
Davall and Sons, Ltd., S.
English Electric Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
Rotol, Ltd.
Weyburn Engineering Co., Ltd., The

GRINDING EQUIPMENT
(see also Tools, machine)
Atlas Copco (Great Britain), Ltd.
Gear Grinding Co., Ltd., The
Headland Engineering Developments, Ltd.
Smart and Brown (Machine Tools), Ltd.

GROUND POWER UNITS
(see also Starters, engine)
Aerocontacts (Ground Equipment), Ltd.
Atlas Copco (Great Britain), Ltd.
Auto Diesels, Ltd.
Blackburn Engines, Ltd.
Coventry Climax Engines, Ltd.
Headland Engineering Developments, Ltd.
Hercules Engineering Co., Ltd., The
Houchin, Ltd.
Murex Welding Processes, Ltd.
Petbow, Ltd.
Rover Gas Turbines, Ltd.
Venner Accumulators, Ltd.
Vernons Industries, Ltd.
Westinghouse Brake and Signal Co., Ltd.

GUIDED WEAPON EQUIPMENT
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Avon India Rubber Co., Ltd., The
Bell Precision Engineering Co., Ltd.
Bradley, Ltd., G. and E.
Bristol Aerojet, Ltd.
British Thomson-Houston Co., Ltd., The
Brown, Ltd., S. G.
Bryans Aeroquipment, Ltd.
Burnley Aircraft Products, Ltd.
Cossor Radar and Electronics, Ltd.
Crossley (Packings), Ltd., Henry
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Dunlop Rubber Co., Ltd.
English Electric Aviation, Ltd.
English Electric Co., Ltd., The
Fairey Aviation, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Gloster Technical Developments Division
Godfrey and Partners, Ltd., Sir George
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
M.B. Metals, Ltd.
M.L. Aviation Co., Ltd.
Miles Structural Plastics, Ltd.
Morfax, Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Redwing, Ltd.
Rotax, Ltd.
Sanders (Electronics), Ltd., W. H.
Sankey and Sons, Ltd., Joseph
SFIM (Great Britain), Ltd.
Short and Mason, Ltd.
Short Bros. and Harland, Ltd.
Siebe, Gorman and Co., Ltd.
Solartron Electronic Group, Ltd., The
Southern Instruments, Ltd.
Sperry Gyroscope Co., Ltd.
Venner Accumulators, Ltd.
Vernons Industries, Ltd.
W.S. Electronics
Woodside Die Sinking Co., Ltd.

GUNS—see Armament

GYRO SYSTEMS
Brown, Ltd., S. G.
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
English Electric Aviation, Ltd.
Ferranti, Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Newmark, Ltd., Louis
Pullin and Co., Ltd., R. B.
Reid and Sigrist, Ltd.
SFIM (Great Britain), Ltd.
Sperry Gyroscope Co., Ltd.

HAIR, RUBBERIZED
(for Packaging, upholstery, etc.)
Hairlok Co., Ltd., The
Microcell, Ltd.
Xetal Products, Ltd.

HANDLING EQUIPMENT, AIRCRAFT
(other than Tractors)
Aviation Traders (Engineering), Ltd.
CJC Developments (Portsmouth), Ltd.
Electro-Hydraulics, Ltd.
Gloster Technical Developments Division
Gordon and Co.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
M.L. Aviation Co., Ltd.
Mercury Airfield Equipment, Ltd.
Morfax, Ltd.
Samlesbury Engineering, Ltd.
Tiltman Langley, Ltd.
Vernons Industries, Ltd.

HANGARAGE
Dundas, Ltd., R. K.
Miles, Ltd., F. G.
Warden Aviation and Engineering Co.

HANGARS
Bellman Hangars, Ltd.
Booth and Sons (Bolton), Ltd., John
British Insulated Callender's Cables, Ltd.
Templewood Hawksley, Ltd.

HARNESS, WIRING
Avica Equipment, Ltd.
C.W.C. Equipment, Ltd.
Ferranti Meters, Ltd., Denis
Grundy and Partners, Ltd.
M.B. Metals, Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Reliance Cords and Cables, Ltd.
Rotax, Ltd.
Scottish Aviation, Ltd.
Tiltman Langley, Ltd.

HARNESSES, AIRCREW AND FITTINGS
Aerolex, Ltd.
Aircraft Materials, Ltd.
G.Q. Parachute Co., Ltd.
Irving Air Chute of Great Britain, Ltd.
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
M.L. Aviation Co., Ltd.
Palmer Aero Products, Ltd.
Redwing, Ltd.
Teleflex Products, Ltd.

HEATERS, AIRCRAFT
Airscrew Co., and Jicwood, Ltd., The
Delaney Gallay, Ltd.
Dragonair, Ltd.
General Electric Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hunting Mhoglas, Ltd.
Isopad, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Marston Excelsior, Ltd.
Plannair, Ltd.
Technograph Electronic Products, Ltd.

HEATERS, HANGAR AND FACTORY
Brown Bros. (Aircraft), Ltd.
Dragonair, Ltd.
General Electric Co., Ltd., The
Hunting Mhoglas, Ltd.

HEAT-EXCHANGERS
Delaney Gallay, Ltd.
Dragonair, Ltd.
Harvey and Co. (London), Ltd., G. A.

Continued overleaf

"Cargo Lift" truck on Carrier Gamecock Chassis: vehicle designed by Rootes Motors, Ltd.; light alloys by Northern Aluminium Co., Ltd., extensively used in body construction

"Halo Ring" universal joint by Mollart Engineering Co., Ltd.

ANCILLARY INDUSTRY 1959...

Hercules Engineering Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
Marston Excelsior, Ltd.
Sankey and Sons, Ltd., Joseph
Serck Radiators, Ltd.
Talbot Stead Tube Co., Ltd.

HEAT-RESISTANT MATERIALS OTHER THAN ALLOYS

Bell's Asbestos and Engineering, Ltd.
British Refrasil Co., Ltd., The
Docker Bros.
Dunlop Rubber Co., Ltd.
Hairlok Co., Ltd., The
Imperial Chemical Industries, Ltd.
Miles Structural Plastics, Ltd.
Modern Industrial Finishes, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Precision Rubbers, Ltd.

HEATING EQUIPMENT, INDUSTRIAL PROCESS

B.R.D. Co., Ltd.
British Thomson-Houston Co., Ltd., The
Dragonair, Ltd.
Gloster Technical Developments Division
Omes, Ltd.
Philips Electrical, Ltd.
Royce Electric Furnaces, Ltd.

HONEYCOMB, METAL

British Refrasil Co., Ltd., The
CIBA (A.R.L.), Ltd.
Delaney Gallay, Ltd.

HOSE, FLEXIBLE

Accles and Pollock, Ltd.
Avica Equipment, Ltd.
Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Boorn and Co., Ltd., Thomas
Brown Bros. (Aircraft), Ltd.
Dunlop Rubber Co., Ltd.
Flexible Ducting, Ltd.
Gordon and Co.
Hall and Hall, Ltd.
High-Pressure Components, Ltd.
Kautex, Ltd.
King Aircraft Corporation
Lockheed Precision Products, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Power Auxiliaries, Ltd.
Precision Rubbers, Ltd.
Sanders (Electronics), Ltd., W. H.
Skyhi, Ltd.
Super Oil Seals and Gaskets, Ltd.
Ward, Brooke and Co., Ltd.

HYDRAULIC EQUIPMENT

Avica Equipment, Ltd.
B.R.D. Co., Ltd.
Bell Precision Engineering Co., Ltd.
Boulton Paul Aircraft, Ltd.
Brown Bros. (Aircraft), Ltd.
de Havilland Propellers, Ltd.
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Exactor, Ltd.
Fairey Aviation, Ltd.
Ferranti Meters, Ltd., Denis
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Gordon and Co
HML (Engineering), Ltd.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Hobson, Ltd., H. M.
Integral, Ltd.
Lockheed Precision Products, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rotol, Ltd.
Skyhi, Ltd.
Sperry Gyroscope Co., Ltd.
Turner Manufacturing Co., Ltd.
Weyburn Engineering Co., Ltd., The
Wilmot Breeden, Ltd.

IGNITION EQUIPMENT

Avica Equipment, Ltd.
British Thomson-Houston Co., Ltd., The
K.L.G. Sparking Plugs, Ltd.
Lodge Plugs, Ltd.
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Smiths Aviation Division
Stewart Aeronautical Supply Co., Ltd.
Venner, Ltd.

INSPECTION EQUIPMENT

Bristol Aircraft, Ltd.
Bryans Aeroquipment, Ltd.
Gloster Technical Developments Division
Goulder and Sons, Ltd., J.
Mollart Engineering Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Taylor, Taylor and Hobson, Ltd.
Wayne Kerr Laboratories, Ltd., The

INSTRUMENTS, AIRCRAFT AND ENGINE

Aircraft Unit Engineering Co.
Appleby and Ireland, Ltd.
Davall and Sons, Ltd., S.
Dowty Nucleonics, Ltd.
Electro Mechanisms, Ltd.
Elliott Bros. (London), Ltd.
Ferranti, Ltd.
Firth Cleveland Instruments, Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Kelvin and Hughes (Aviation), Ltd.
Mechanism, Ltd.
Miles Electronics, Ltd.
Munro, Ltd., R. W.
Negretti and Zambra, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Pullin and Co., Ltd., R. B.
Reid and Sigrist, Ltd.
Salford Electrical Instruments, Ltd.
Sangamo Weston, Ltd.
SFIM (Great Britain), Ltd.
Smiths Aviation Division
Sperry Gyroscope Co., Ltd.
Wynstruments, Ltd.

INSTRUMENTS, OTHER THAN ABOVE

(see under Test equipment, Drawing office equipment, etc.)

INSULATION, ELECTRICAL

Bell's Asbestos and Engineering, Ltd.
British Insulated Callender's Cables, Ltd.
Coin Insulation, Ltd.
Ericsson Telephones, Ltd.
Fibreglass, Ltd.
General Electric Co., Ltd., The
Hordern-Richmond, Ltd.
Imperial Chemical Industries, Ltd.
Northern Rubber Co., Ltd., The
Steatite and Porcelain Products, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Tufnol, Ltd.
Ward, Brooke and Co., Ltd.

INSULATION, SOUND

Anticoustic Co., The
Bell's Asbestos and Engineering, Ltd.
Cullum and Co., Ltd., Horace W.
Fibreglass, Ltd.
Jablo Propellers, Ltd.
Newalls Insulation Co., Ltd.

INSULATION, THERMAL

Bell's Asbestos and Engineering, Ltd.
British Refrasil Co., Ltd., The
Delaney Gallay, Ltd.
Fibreglass, Ltd.
Flexible Ducting, Ltd.
Jablo Propellers, Ltd.
Newalls Insulation Co., Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Tufnol, Ltd.

INSURANCE

British Aviation Insurance Co., Ltd., The
Denney, O'Hara, Ltd.
Helicopter Sales, Ltd.

JACKS (AIRCRAFT COMPONENT)

Boulton Paul Aircraft, Ltd.
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Gloster Technical Developments Division
Gordon and Co.
Hercules Engineering Co., Ltd., The
Hymatic Engineering Co., Ltd., The
Lockheed Precision Products, Ltd.
Morfax, Ltd.
Rotax, Ltd.
Rotol, Ltd.
Teddington Aircraft Controls, Ltd.
Teleflex Products, Ltd.
Turner Manufacturing Co., Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.

JACKS (LIFTING, FOR MAINTENANCE, ETC.)

Aero Controls, Ltd.
Autoset (Production), Ltd.
B.R.D. Co., Ltd.
Brown Bros. (Aircraft), Ltd.
Electro-Hydraulics, Ltd.
Gloster Technical Developments Division
Gordon and Co.
Hercules Engineering Co., Ltd., The
Morfax, Ltd.
Skyhi, Ltd.
Woodside Die Sinking Co., Ltd.

JIGS AND FIXTURES

Aero Controls, Ltd.
Aerolex, Ltd.
Aircraft Materials, Ltd.
Amar Tool and Gauge Co., Ltd.
B.R.D. Co., Ltd.
Bell Precision Engineering Co., Ltd.
CJC Developments (Portsmouth), Ltd.
Chinn and Co., Ltd., J. S.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
Cramic Aircraft Components, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Erith Engineering (Leicester), Ltd.
Fairey Aviation, Ltd.
Goulder and Sons, Ltd., J.
Harolds Gauges, Ltd.
Headland Engineering Developments, Ltd.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Hordern-Richmond, Ltd.
Lancefield Aircraft Components, Ltd.
Miles, Ltd., F. G.
Mollart Engineering Co., Ltd., The
Morfax, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Portsmouth Aviation, Ltd.
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Tufnol, Ltd.
Vactric (Precision Tools), Ltd.
Villiers (Tool Developments), Ltd.
Walker (Architectural Decorations), Ltd.
Woodside Die Sinking Co., Ltd.

JIGS AND FIXTURES, STANDARD PARTS FOR CONSTRUCTION OF

B.R.D. Co, Ltd.
Fairey Aviation, Ltd.
Hercules Engineering Co., Ltd., The
Miles Structural Plastics, Ltd.
Mining and Chemical Products, Ltd.
Morfax, Ltd.
Purefoy Unit Tooling, Ltd., J. B.
Villiers (Tool Developments), Ltd.
Woodside Die Sinking Co., Ltd.

JOINTING MATERIALS AND COMPOUNDS

(see also Gaskets, Seals, Sealants, and Sealants, Runway Jointing)

Aircraft Materials, Ltd.
B.B. Chemical Co., Ltd.
Bell's Asbestos and Engineering, Ltd.
British Paints, Ltd.
Celion, Ltd.
Coopers Mechanical Joints, Ltd.
Docker Bros.
Dowty Seals, Ltd.
Fireproof Tanks, Ltd.
Goodyear Tyre and Rubber Co. (Great Britain), Ltd., The
Hall and Hall, Ltd.
Imperial Chemical Industries, Ltd.
Jablo Propellers, Ltd.
Kane, Ltd., Douglas
Kautex, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Lucas (Gas Turbine Equipment), Ltd., Joseph
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Ryland, Ltd., Llewellyn
Titanine, Ltd.
Turner Bros. Asbestos Co., Ltd.
Walker and Co., Ltd., James
Wills Pressure Filled Joint Ring, Ltd.

JOINTS, UNIVERSAL

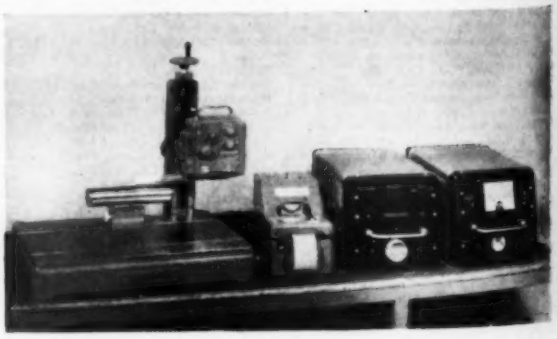
Aero Controls, Ltd.
Avica Equipment, Ltd.
Avon India Rubber Co., Ltd., The
B.R.D. Co., Ltd.
Girling, Ltd.
Hardy Spicer, Ltd.
Mollart Engineering Co., Ltd., The
Palmer Aero Products, Ltd.

LABORATORY EQUIPMENT

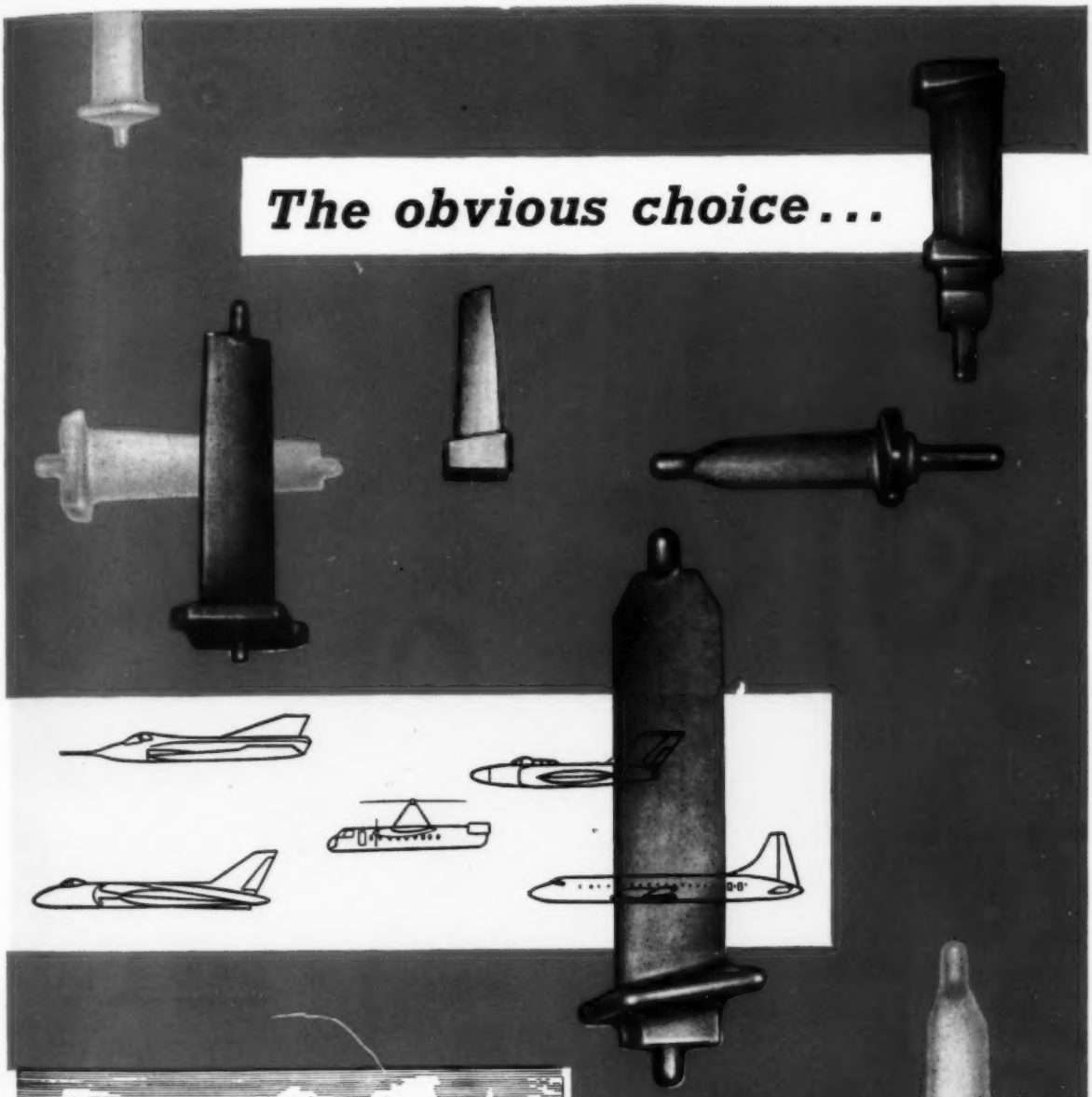
(see also Test equipment)

Aircraft Materials, Ltd.
Blackburn Electronics, Ltd.
Bradley, Ltd., G. and E.
Brown, Ltd., S. G.
Bryans Aeroquipment, Ltd.
Burndept, Ltd.
Davall and Sons, Ltd., S.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Ferranti Meters, Ltd., Denis
Sanders (Electronics), Ltd., W. H.
Wayne Kerr Laboratories, Ltd., The

Model 3 "Talysurf" surface-measuring instrument (Taylor, Taylor and Hobson, Ltd.)

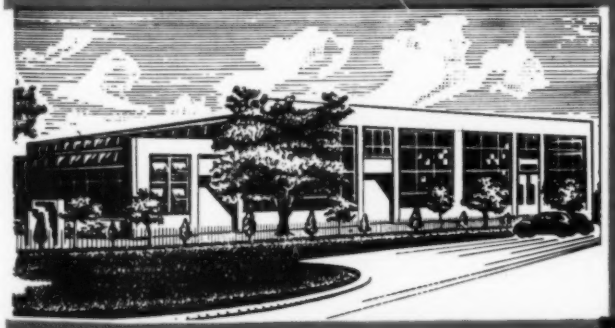


The obvious choice...



These blades are precision forged in the forging shop specially built and specially equipped, with the largest capacity in Europe for the production of forgings for the Aircraft Industry.

The materials forged include
STAINLESS STEELS, ALUMINIUM ALLOYS, ALUMINIUM BRONZES, NICKEL ALLOYS AND TITANIUM ALLOYS



precision blades by **GARRINGTONS**

GARRINGTONS LIMITED, BROMSGROVE, WORCS.

S.B.A.C.
Flying Display and Exhibition Stand No. 160

CELLON provide the finish for Bristol Plastic Drop Tanks

These tanks, made from asbestos reinforced phenolic plastic, are finished in accordance with the camouflage scheme of the aircraft to which they are fitted. Aerodynamic performance is important and the smoothness and durability of the finish a vital factor. For this reason Bristol Aircraft Limited rely on Cellon Aircraft Finishes.

With the march of progress new finishing problems in the aircraft industry are constantly arising but assiduous research enables Cellon to meet the challenge. Specialised resistant finishing schemes are now available for supersonic aircraft, guided missiles and even "flying saucers."

CELLON AIRCRAFT FINISHES

CELLON LIMITED, KINGSTON-ON-THAMES, ENGLAND TELEPHONE: KINGSTON 1234 (9 LINES) TELEGRAMS: "AJAWB, 'PHONE, KINGSTON-ON-THAMES"
ALSO MANUFACTURED IN AUSTRALIA, CANADA, FRANCE, HOLLAND, INDIA & NORWAY

CVS-500

SAFETY in fluid control depends upon RELIABILITY as demonstrated by 5,000,000 operation endurance test with SAUNDERS Mark 4 Spherical Plug Valve

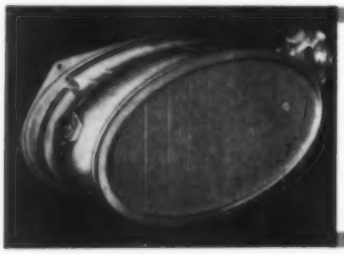
SAUNDERS AERO VALVES

SAUNDERS VALVE COMPANY LIMITED
AIRCRAFT DIVISION
BLACKFRIARS STREET · HEREFORD

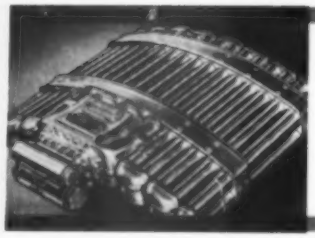
Delaney Gallay LTD

see us at Farnborough

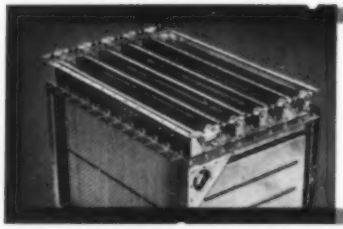
WE SHALL BE EXHIBITING



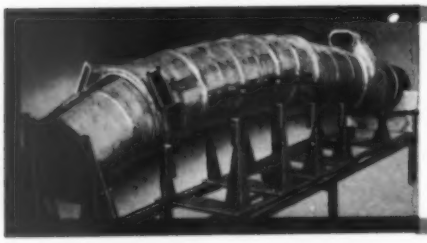
Oil Coolers in light alloy. They are light, compact, and can be designed to fit almost any space, no matter how awkward.



Fuel-cooled Oil Cooler for gas turbine and turbo-prop engines. By using fuel as the coolant, these units cool the oil and warm the fuel at the same time, an obvious advantage when using kerosine at high altitudes.



Anti-Icing Heat Exchangers. Our system uses hot gas from the exhaust or engine compressor to heat air which is then piped to the aerofoils. It prevents ice from forming, is non-electric and has no moving parts other than an on-off control.



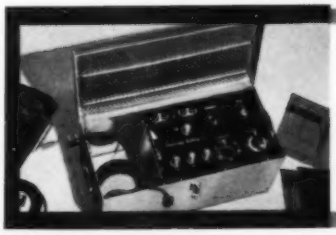
Thermal Insulation Blankets. Constructed from the insulant Thermoflex R.F.300 sandwiched between dimpled ·004in. stainless steel. Welded channel edges are completely sealed against the ingress of fuel. Average weight: 0·65 lb. per sq. ft. We 'make to measure' to suit any installation. No problem of size or shape is too difficult.

Stainless Steel Toilets. Self-contained **flushing** toilets requiring no ground equipment, extra tanks or bulkhead stressing. They obviate fuselage corrosion and are interchangeable with existing units. **Delaney Gallay Toilet Fluid.** A new formula that definitely kills odours and sterilizes. It is not affected by high altitudes or temperatures.

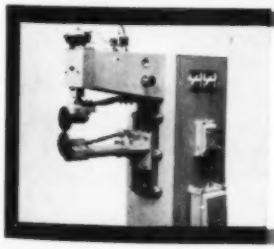
ghon Stands Nos. 8 & 268

Flux Bath Brazing. A process for light alloy brazing that permits inaccessible joint to be made, without intolerable distortion, in metal as thin as ·006in. It is a simple fact that units can be made in the flux both so small and so light that it would be impossible to make them by any other method. We shall be exhibiting examples of such work.

Stainless Steel Fabrication. We have developed techniques that often enable us to make direct from strip items that would normally have to be drawn or forged. We can often, therefore, obviate the necessity for lengthy and costly tooling processes, and can work equally well in any gauge from ·002in to ¼in.



The 'Incorporall' Portable Welding Kit. A completely self-contained kit for welding mild and stainless steels up to 22G. The electrode can be used either in a hand gun or as a foot-operated pencil unit. The 'Incorporall' is suitable for all climates and is complete with tools and operating data.



Universal] Welder. With attachments, this machine is equally suitable for seam, spot or projection welding. Its bottom electrode carrier is mounted on a curved seating that can be tilted so that alignment is always perfect. We shall also have other machines on show, including a seam welder that can operate when only one side of the job is accessible.

See them all on our

Stands at Farnborough—Nos. 8 & 268

Delaney Gallay LTD

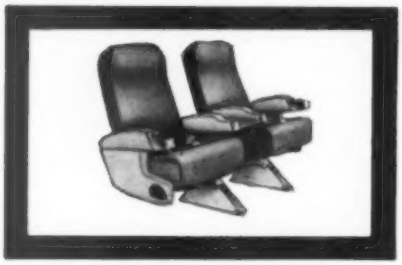
Vacuum Brazing

We have now installed what we believe to be the largest vacuum furnace in Europe for brazing stainless steel and titanium. Please ask us for details.

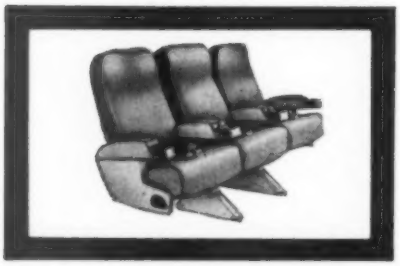
Vulcan Works, Edgware Road, London, N.W.2. Telephone: GLAdstone 2201

Microcell *Executive* Aircraft Seating

FOR
B·O·A·C
FIRST CLASS AND DE-LUXE TRAVEL



DE-LUXE "EXECUTIVE" SEAT.
For special luxury accommodation. This unit is basically similar to the normal twin unit but incorporates a wide contemporary styled cabinet and tray unit, between the two seat places.



EXECUTIVE TRIPLE UNIT AIRCRAFT SEAT
Available also as Twin Unit for forward or aft facing

THE MICROCELL "EXECUTIVE" AIRCRAFT SEAT is unique in combining the simplest possible structure with the fulfilment of all known operational requirements.

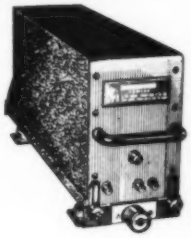
This has been accomplished by adopting "Single Beam Unit Construction", an original concept in the use of standardised and therefore readily interchangeable components.

A Division of Microcell Limited
9, Kingsway, London, W.C.2
Telephone: Covent Garden 1262

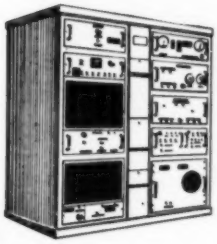
COSSOR

Secondary Surveillance Radar Interrogator-Responsor. The ground equipment of the secondary radar system for Air Traffic Control.

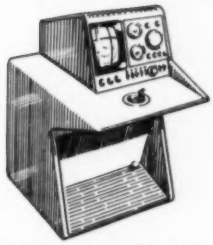
Radar & Electronics Limited



The ATC Airborne Secondary Radar Transponder SSR.1251. Designed to meet I.C.A.O. and ARINC requirements including those for sidelobe suppression.

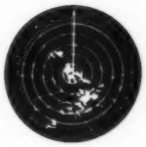


The CR.787 S-Band Airfield Control Radar. A medium range static or mobile primary radar with M.T.I. and circular polarisation.

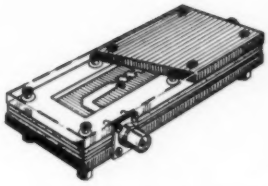


The Windfinding Radar Type 353. A high-performance search and trecking radar for the determination of wind velocities.

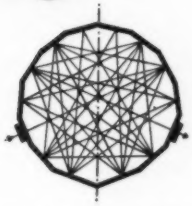
...gh



The C.R.D. 23 ATC Radar Display System. An advanced equipment with full interscan facilities for the P.P.I. presentation of air traffic control information.



Cossor Strip Transmission Lines. A revolutionary advance in microwave engineering.

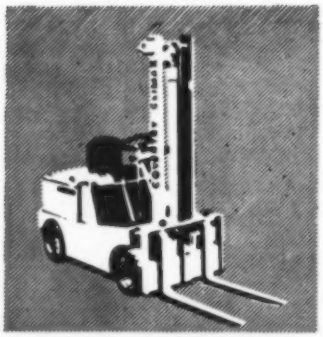


Quartz Delay Lines providing delays of 3 to 2500 μs. At 20 Mc/s centre frequency, the bandwidth is 4½ Mc/s.

We shall be pleased to discuss these and other products with you on **Stand 231**

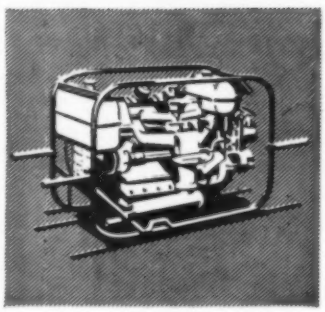
CR 82

ELECTRIC
FORK LIFT TRUCKS
up to 4,500 lb. capacity



DIESEL and PETROL
FORK LIFT TRUCKS
up to 7,000 lb. capacity

PORTABLE and
TRAILER FIRE PUMPS
"The fire pump engine
that wins races"



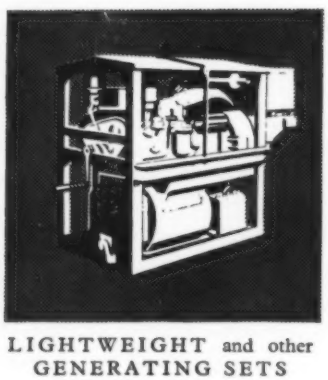
World renowned for Reliability . . .

Some Coventry Climax products backed by more than 50 years of engine-building experience

Coventry Climax

GODIVA High Performance
OUTBOARD ENGINES

UNIVERSAL FIRE PUMPS
for Fire Engines and Tenders



LIGHTWEIGHT and other
GENERATING SETS

COVENTRY CLIMAX ENGINES LTD.
COVENTRY

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LADDERS
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Aviation Traders (Engineering), Ltd.
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Hemball and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
Morfax, Ltd.

LANDING GEAR
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Dowty Equipment, Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Hercules Engineering Co., Ltd., The
Lockheed Precision Products, Ltd.
Palmer Aero Products, Ltd.
Rotol, Ltd.
Turner Manufacturing Co., Ltd.
Vickers-Armstrongs (Aircraft), Ltd.
Walter, Ltd., A. J.

LEATHER
Connolly Bros. (Curriers), Ltd.

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Elliot Equipment, Ltd.
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Jablo Propellers, Ltd.
R.F.D. Co., Ltd.
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Aircraft Materials, Ltd.
Beaufort (Air Sea) Equipment, Ltd.
Davall and Sons, Ltd., S.
Elliot Equipment, Ltd.
Ferranti Meters, Ltd., Denis
Frankenstein and Sons (Manchester), Ltd., P.
Graviner Colnbrook
Harley Aircraft Landing Lamps
Jablo Propellers, Ltd.
Kidde Co., Ltd., The Walter
M.L. Aviation Co., Ltd.
Martin Baker Aircraft Co.
Minnesota Mining and Manufacturing Co., Ltd.
Palmer Aero Products, Ltd.
R.F.D. Co., Ltd.
Schermuly Pistol Rocket Apparatus Ltd., The
Siebe, Gorman and Co., Ltd.
Teleflex Products, Ltd.
Ultra Electric, Ltd.
Ward, Brooke and Co., Ltd.

LIGHTING EQUIPMENT, AIRCRAFT
Ceag, Ltd.
English Electric Co., Ltd., The
General Electric Co., Ltd., The
Harley Aircraft Landing Lamps
M.B. Metals, Ltd.
M.L. Aviation Co., Ltd.
Philips Electrical, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Siemens Edison Swan, Ltd.
Sunstex Safety Glass Industries, Ltd.
Thorn Electrical Industries, Ltd.
Venner, Ltd.
Ward, Brooke and Co., Ltd.

LIGHTING EQUIPMENT, AIRFIELD
Blackburn Engines, Ltd.
Ceag, Ltd.
Coventry Climax Engines, Ltd.
General Electric Co., Ltd., The
Harley Aircraft Landing Lamps
Philips Electrical, Ltd.
Siemens Edison Swan, Ltd.

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Philips Electrical, Ltd.
Siemens Edison Swan, Ltd.
Sunstex Safety Glass Industries, Ltd.

LOCK WASHERS, LEAKPROOF
Aircraft Materials, Ltd.
Dowty Seals, Ltd.
Kaye, Ltd., Douglas
Parsons, Ltd., J. R.

LOCKNUTS
Aircraft Materials, Ltd.
Aviation Developments, Ltd.
Brown Bros. (Aircraft), Ltd.
Girdlestone Pumps, Ltd.
Guest, Keen and Nettlefolds (Midlands), Ltd.
Kaye, Ltd., Douglas
Parsons, Ltd., J. R.
Simmonds Aerocessories, Ltd.
Whitehouse Industries, Ltd. (Phillidas Division)

LOCKS, DOOR
Hercules Engineering Co., Ltd., The
King Aircraft Corporation

LUBRICANTS
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Esso Petroleum Co., Ltd.
Imperial Chemical Industries, Ltd.
Manchester Oil Refinery (Sales), Ltd.
Regent Oil Co., Ltd.
Shell-Mex and BP, Ltd.
Vaughan and Co., Ltd., Edgar
Wakefield and Co., Ltd., C. C.
Wakefield-Dick Industrial Oils, Ltd.

LUBRICATING EQUIPMENT FOR SERVICING
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Mills, Ltd., William
Tecalemit, Ltd.
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Booth and Co., Ltd., James
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Kent Alloys, Ltd.
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C. and N. (Electrical), Ltd.
Fairey Marine, Ltd.
Jablo Propellers, Ltd.
Saunders-Roe (Anglesey), Ltd.
Vosper, Ltd.

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Aerocontacts (Ground Equipment), Ltd.
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Aviation Traders (Engineering), Ltd.
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Edghill and Co., Ltd., H. W.
General Electric Co., Ltd., The
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Hunting Engineering, Ltd.
Mercury Airfield Equipment, Ltd.
Short Bros. and Harland, Ltd.
Tiltman Langley, Ltd.
Vaughan Crane Co., Ltd., The
Villiers (Tool Developments), Ltd.
Western Manufacturing (Reading), Ltd.

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Metachemical Processes, Ltd.
Morfax, Ltd.
Portsmouth Aviation, Ltd.
Pyrene Co., Ltd., The

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Burnley Aircraft Products, Ltd.
Mining and Chemical Products, Ltd.

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Cossor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
Decca Radar, Ltd.
Mechanism, Ltd.
Munro, Ltd., R. W.
Negretti and Zambra, Ltd.
Short and Mason, Ltd.

MICROPHONES
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Amplivox, Ltd.
Anticoustic Co., The
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Electro Mechanisms, Ltd.
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General Electric Co., Ltd., The
Philips Electrical, Ltd.
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Standard Telephones and Cables, Ltd.
Trix Electrical Co., Ltd., The

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Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Bell Precision Engineering Co., Ltd.
Brown, Ltd., S. G.
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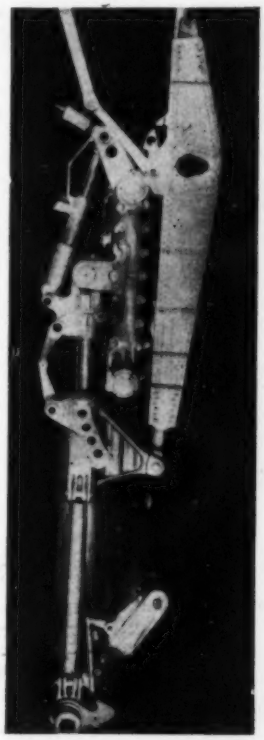
Hordern-Richmond, Ltd.
Hunting Aerosurveys, Ltd.
Saunders-Roe, Ltd.
Walker (Architectural Decorations), Ltd., James
Westway Models, Ltd.
Woodside Die Sinking Co., Ltd.



Electro-Hydraulics, Ltd., main undercarriage leg for Handley Page Victor

MOTORS, ELECTRIC
British Thomson-Houston Co., Ltd., The
Brown, Ltd., S. G.
Elliott Bros. (London), Ltd.
English Electric Co., Ltd., The
Graseby Instruments, Ltd.
Newton Bros. (Derby), Ltd.
Plessey Co., Ltd., The
Pullin and Co., Ltd., R. B.
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Cementation (Muffelite), Ltd.
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Fairey Air Surveys, Ltd.
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Turner and Co., Ltd., Luke

MUFFLERS, GROUND, FOR JET ENGINES
Burnley Aircraft Products, Ltd.
Cementation (Muffelite), Ltd.
Cullum Detuners, Ltd.
Curran, Ltd., John
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Ekco Electronics, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Murphy Radio, Ltd. (Electronics Division)
Newmark, Ltd., Louis
Plessey Co., Ltd., The
Pye Telecommunications, Ltd.
Redifon, Ltd.
Sperry Gyroscope Co., Ltd.
Standard Telephones and Cables, Ltd.
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Ferranti, Ltd.
Graseby Instruments, Ltd.
Kelvin and Hughes (Aviation), Ltd.
Pullin and Co., Ltd., R. B.
Smiths Aviation Division
Sperry Gyroscope Co., Ltd.

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Goodyear Tyre and Rubber Co. (Great Britain), Ltd., The
Hall and Hall, Ltd.
Kautex, Ltd.
Nothern Rubber Co., Ltd., The

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Aircraft Materials, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Fox and Co., Ltd., Samuel
Heckford, Ltd., Arthur E.
Mond Nickel Co., Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Wiggin and Co., Ltd., Henry

NUCLEAR POWER EQUIPMENT
Accles and Pollock, Ltd.
Aero Controls, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
British Refrasil Co., Ltd., The
British Thomson-Houston Co., Ltd.
C. and N. (Electrical), Ltd.
Cole, Ltd., E. K.
de Havilland Engine Co., Ltd., The
Dowty Nucleonics, Ltd.
Ekco Electronics, Ltd.
Electro-Hydraulics, Ltd.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Flight Refuelling, Ltd.
Harvey and Co. (London), Ltd., G. A.
High-Pressure Components, Ltd.
Hobson, Ltd., H. M.
Kent, Ltd., George
Marston Excelsior, Ltd.
Miles Electronics, Ltd.
Plessey Nucleonics, Ltd.
Short and Mason, Ltd.
Siebe, Gorman and Co., Ltd.

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Minnesota Mining and Manufacturing Co., Ltd.
Redwing, Ltd.
Rubery Owen and Co., Ltd.

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Airscrew Co., and Jicwood, Ltd., The
Delaney Gallay, Ltd.

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Serck Radiators, Ltd.
Walter, Ltd., A. J.

OPTICAL ELEMENTS
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Harringay Photographic and Electrical Supplies, Ltd.
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British Oxygen Gases, Ltd.
Chesterfield Tube Co., Ltd., The
Ferranti Meters, Ltd., Denis
Hymatic Engineering Co., Ltd., The
Kidde Co., Ltd., The Walter
Normalair, Ltd.
Palmer Aero Products, Ltd.
Siebe, Gorman and Co., Ltd.

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Avon India Rubber Co., Ltd., The
Brand and Co., Ltd., R. A.
E.P.S. (Research and Development), Ltd.

PACKAGING, PRESERVATION AND DISPATCH
Airmed, Ltd.
Bakelite, Ltd.
Brand and Co., Ltd., R. A.
Cossor Radar and Electronics, Ltd.
E.P.S. (Research and Development), Ltd.
Export Packing Service, Ltd.
Jablo Plastics Industries, Ltd.
M.B. Metals, Ltd.
Microcell, Ltd.
Park, Ltd., R. and J.
Salter and Co., Ltd., Geo.
Scotney, Ltd., Tom M.

PACKINGS—see Jointing materials, Seals, Gaskets.

PAINT REMOVERS
Brent Chemical Products, Ltd.
British Paints, Ltd.
Cellon, Ltd.
Docker Bros.
Ericsson Telephones, Ltd.
Hall and Sons (Bristol and London), Ltd.
Imperial Chemical Industries, Ltd.
Modern Industrial Finishes, Ltd.
Ryland, Ltd., Llewellyn
Titanine, Ltd.
Valay Industries, Ltd.

PAINTS OTHER THAN AIRCRAFT FINISHES AND PROTECTIVE PROCESSES
Cellon, Ltd.
Docker Bros.
Ericsson Telephones, Ltd.
Hall and Sons (Bristol and London), Ltd.
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Modern Industrial Finishes, Ltd.
Ryland, Ltd., Llewellyn
Titanine, Ltd.

PARACHUTES, AIRCREW
G.Q. Parachute Co., Ltd.
Irving Air Chute of Great Britain, Ltd.

PARACHUTES, SPECIAL-PURPOSE, OTHER THAN AIRCREW
G.Q. Parachute Co., Ltd.
Irving Air Chute of Great Britain, Ltd.
Ward, Brooke and Co., Ltd.

PARTS, MACHINED (see also Components, Tubular components, etc.)
Abbey Engineering Co. (Coventry), Ltd.
Aero Controls, Ltd.
Aircraft Materials, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
B.R.D. Co., Ltd.
Brown Bros. (Aircraft), Ltd.
Brown, Ltd., S. G.
CJC Developments (Portsmouth), Ltd.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
Cramic Aircraft Components, Ltd.
de Havilland Engine Co., Ltd., The
Ferranti Meters, Ltd., Denis
Field Aircraft Services, Ltd.
Graseby Instruments, Ltd.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Kelston Engineering Co., Ltd.
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Mollart Engineering Co., Ltd., The
Morfax, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Palmer Aero Products, Ltd.
Parsons, Ltd., J. R.
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Rubery Owen and Co., Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
Spa Guilds, Ltd.
Talbot Stead Tube Co., Ltd.
Tiltman Langley, Ltd.
Tungum Co., Ltd., The
Turner Manufacturing Co., Ltd.
Williamson Manufacturing Co., Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.
Yorkshire Engineering Supplies, Ltd.

PARTS, TUBULAR
Accles and Pollock, Ltd.
Aviation Traders (Engineering), Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
Morfax, Ltd.
Palmer Aero Products, Ltd.
Portsmouth Aviation, Ltd.
Reynolds Tube Co., Ltd.
Samlesbury Engineering Ltd.
Scottish Aviation, Ltd.
Tiltman Langley, Ltd.
Tungum Co., Ltd., The
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.

PASSENGER PERSONAL EQUIPMENT
Aerocontacts (Sales), Ltd.
Aerogalley

PATTERNS, CASTING
Bakelite, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Stone and Co. (Charlton), Ltd., J.
Walker (Architectural Decorations), Ltd., James

PHOTOGRAMMETRIC EQUIPMENT
E.M.I. Electronics, Ltd.
Harringay Photographic and Electrical Supplies, Ltd.
Williamson Manufacturing Co., Ltd.
Young, Ltd., A. W.

PHOTOGRAPHIC MATERIALS AND EQUIPMENT
Direct Photographic Supply Co.
Fairey Air Surveys, Ltd.
Harringay Photographic and Electrical Supplies, Ltd.
Philips Electrical, Ltd.
Vinten, Ltd., W.
Williamson Manufacturing Co., Ltd.
Young, Ltd., A. W.

PHOTOGRAPHY, GENERAL
Fairey Air Surveys, Ltd.
Harringay Photographic and Electrical Supplies, Ltd.
Hunting Aerosurveys, Ltd.
Vinten, Ltd., W.

PIPEWORK, FABRICATED
Accles and Pollock, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
Avica Equipment, Ltd.
Bramah and Co., Ltd., J. R.
Burnley Aircraft Products, Ltd.
Corner and Co., Ltd., G.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Fairey Aviation, Ltd.
Gordon and Co.
Harvey and Co. (London), Ltd., G. A.
Henderson Safety Tank Co., Ltd., The
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Morfax, Ltd.
Palmer Aero Products, Ltd.
Portsmouth Aviation, Ltd.
Scottish Aviation, Ltd.
Talbot Stead Tube Co., Ltd.
Tiltman Langley, Ltd.
Wilmot Breeden, Ltd.

PIEZO-ELECTRIC MATERIALS
Brush Crystal Co., Ltd., The
Salford Electrical Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Technical Ceramics, Ltd.

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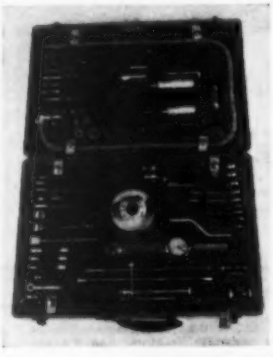
Cross Manufacturing Co. (1938), Ltd.
de Havilland Engine Co., Ltd., The
Hepworth and Grandage, Ltd.
Wellworthy, Ltd.

PLASTIC METAL FILLERS
Aircraft Materials, Ltd.
de Havilland Propellers, Ltd.
Kane, Ltd., Douglas
Kenilworth Manufacturing Co., Ltd., The
Wills Pressure Filled Joint Ring, Ltd.

PLASTICS, EXPANDED
Bakelite, Ltd.
de Havilland Propellers, Ltd.
English Electric Aviation, Ltd.
Hercules Engineering Co., Ltd., The
Imperial Chemical Industries, Ltd.
Jablo Plastics Industries, Ltd.
Palmer Aero Products, Ltd.
Saro Laminated Wood Products, Ltd.
Thermo Plastics, Ltd.
Ward, Brooke and Co., Ltd.



Glass-fibre tool-case, supplied by Microcell, Ltd., to Rolls-Royce, Ltd., for engine maintenance kits

PLASTICS, EXTRUSIONS
Bakelite, Ltd.
British Industrial Plastics, Ltd.
Crossley (Packings), Ltd., Henry
English Electric Aviation, Ltd.
Hellermann, Ltd.
Hunting Aircraft, Ltd.
Imperial Chemical Industries, Ltd.
Palmer Aero Products, Ltd.
St. Helens Cable and Rubber Co., Ltd.
Sciaky Electric Welding Machines, Ltd.
Siemens Edison Swan, Ltd.
Suntex Safety Glass Industries, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Walker (Architectural Decorations), Ltd., James
Ward, Brooke and Co., Ltd.

PLASTICS, FABRICATED
Aerogalley
Airscrew Co. and Jicwood, Ltd., The
Attewell and Sons, Ltd., B.
Bakelite, Ltd.
Bristol Aircraft, Ltd.
British Industrial Plastics, Ltd.
Coin Insulation, Ltd.
Crossley (Packings), Ltd., Henry
de Havilland Propellers, Ltd.
Dunlop Rubber Co., Ltd.
English Electric Aviation, Ltd.
Fireproof Tanks, Ltd.
Hercules Engineering Co., Ltd., The
Hordern-Richmond, Ltd.
Hunting Aircraft, Ltd.
Imperial Chemical Industries, Ltd.
Jablo Plastics Industries, Ltd.
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Palmer Aero Products, Ltd.
Parnall and Co., Ltd., George
St. Helens Cable and Rubber Co., Ltd.
Sciaky Electric Welding Machines, Ltd.
Siemens Edison Swan, Ltd.
Suntex Safety Glass Industries, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Thermo Plastics, Ltd.
Triplex Safety Glass Co., Ltd.
Ward, Brooke and Co., Ltd.
Williamson Manufacturing Co., Ltd.

PLASTICS, GLASS FIBRE
Bakelite, Ltd.
British Industrial Plastics, Ltd.
Coin Insulation, Ltd.
Cossor Radar and Electronics, Ltd.
Crossley (Packings), Ltd., Henry
de Havilland Propellers, Ltd.
English Electric Aviation, Ltd.
Fairey Marine, Ltd.
Ferranti Meters, Ltd., Denis
Fibreglass, Ltd.
Fothergill and Harvey, Ltd.
Hawley Products, Ltd.
Hercules Engineering Co., Ltd., The
Hordern-Richmond, Ltd.
Imperial Chemical Industries, Ltd.
Jablo Plastics Industries, Ltd.
Kidde Co., Ltd., The Walter
King Aircraft Corporation
Marston Excelsior, Ltd.
Microcell, Ltd.
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Palmer Aero Products, Ltd.
Rollason Aircraft and Engines, Ltd.
Saro Laminated Wood Products, Ltd.
Saunders-Roe (Anglesey), Ltd.
Sciaky Electric Welding Machines, Ltd.
Thermo Plastics, Ltd.
Turner Bros. Asbestos Co., Ltd.
Walker (Architectural Decorations), Ltd., James
Ward, Brooke and Co., Ltd.
Wills Pressure Filled Joint Ring, Ltd.

PLASTICS, LAMINATED
Bakelite, Ltd.
Coin Insulation, Ltd.
Crossley (Packings), Ltd., Henry
de Havilland Propellers, Ltd.
English Electric Aviation, Ltd.
Hordern-Richmond, Ltd.
Imperial Chemical Industries, Ltd.
Jablo Plastics Industries, Ltd.
Marston Excelsior, Ltd.
Microcell, Ltd.
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Palmer Aero Products, Ltd.
Sciaky Electric Welding Machines, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Thermo Plastics, Ltd.
Tufnol, Ltd.
Ward, Brooke and Co., Ltd.
Wills Pressure Filled Joint Ring, Ltd.

PLASTICS, MOULDED
Aerogalley
Attewell and Sons, Ltd., B.
Bakelite, Ltd.
Bristol Aircraft, Ltd.
British Industrial Plastics, Ltd.
Chelton (Electrostatics), Ltd.
Cornercroft, Ltd.
Cossor Radar and Electronics, Ltd.
Crossley (Packings), Ltd., Henry
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Dunlop Rubber Co., Ltd.
English Electric Aviation, Ltd.
Ferranti Meters, Ltd., Denis
Frankenstein and Sons (Manchester), Ltd., P.
Girdlestone Pumps, Ltd.
Hawley Products, Ltd.
Hellermann, Ltd.
Hordern-Richmond, Ltd.
Hunting Aircraft, Ltd.
Imperial Chemical Industries, Ltd.
Long and Hambly, Ltd.
M.B. Metals, Ltd.
Microcell, Ltd.
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Palmer Aero Products, Ltd.
Parnall and Co. Ltd., George
Sciaky Electric Welding Machines, Ltd.

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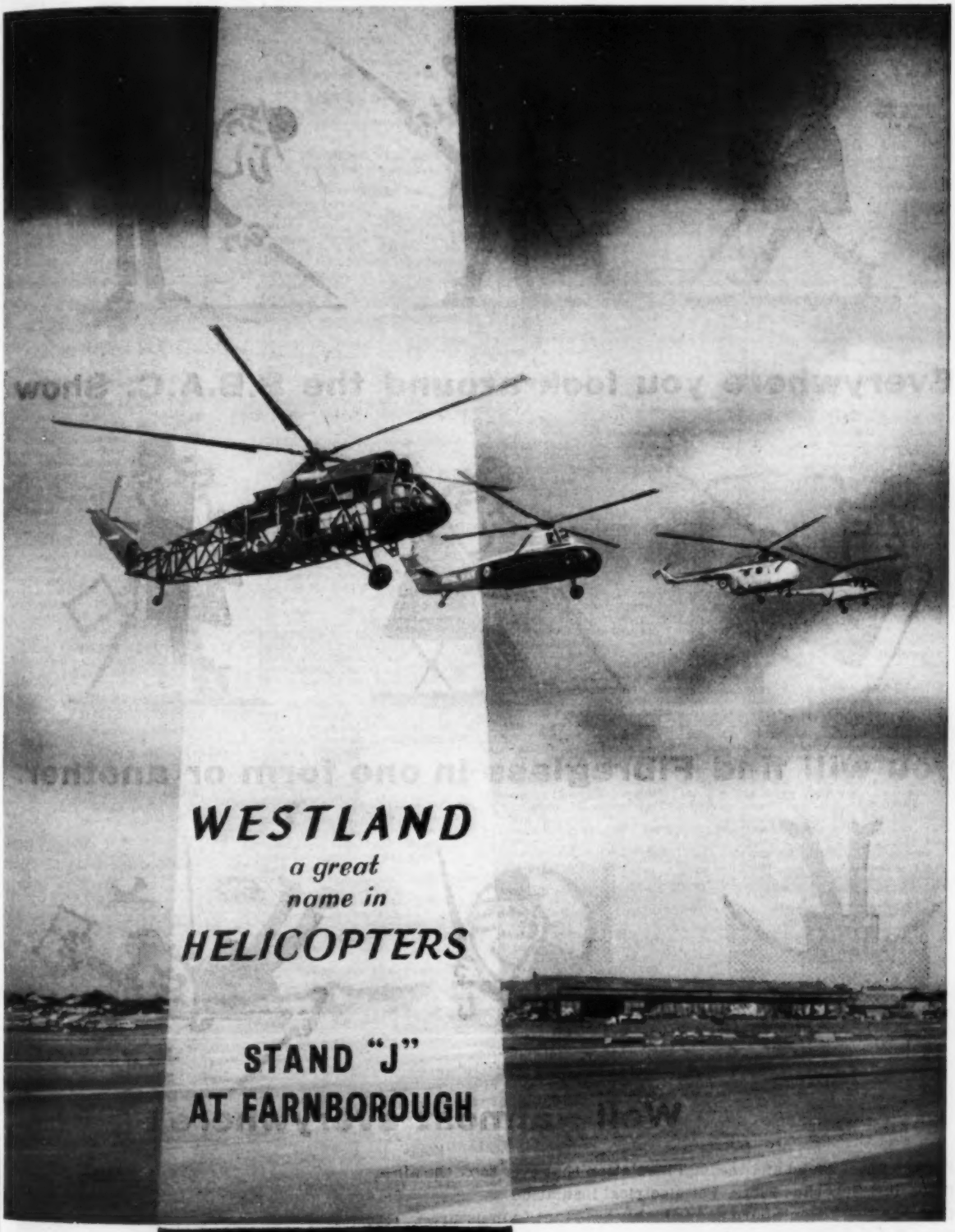

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Telegraph Construction and Maintenance Co., Ltd., The
Thermo Plastics, Ltd.
Tufnol, Ltd.
Turner Electrical Instruments, Ltd., Ernest
Walker (Architectural Decorations), Ltd., James
Ward, Brooke and Co., Ltd.
Wayne Kerr Laboratories, Ltd., The
Wills Pressure Filled Joint Ring, Ltd.

PLASTICS, RAW MATERIALS

Albright and Wilson (Mfg.), Ltd.
Bakelite, Ltd.
British Industrial Plastics, Ltd.
English Electric Aviation, Ltd.
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Laporte Chemicals, Ltd.
Palmer Aero Products, Ltd.
United Coke and Chemicals Co., Ltd.
United Steel Companies, Ltd., The

PLASTICS, SHEETING

Bakelite, Ltd.
British Industrial Plastics, Ltd.
Dunlop Rubber Co., Ltd.
English Electric Aviation, Ltd.
Hordern-Richmond, Ltd.
I.C.I. (Hyde), Ltd.
Imperial Chemical Industries, Ltd.
Jablo Plastics Industries, Ltd.
Lancefield Aircraft Components, Ltd.
Miles Structural Plastics, Ltd.
Palmer Aero Products, Ltd.
Saro Laminated Wood Products, Ltd.
Sciaky Electric Welding Machines, Ltd.
Siemens, Edison Swan, Ltd.
Suntex Safety Glass Industries, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Thermo Plastics, Ltd.
Tufnol, Ltd.
Wills Pressure Filled Joint Ring, Ltd.

PLATING, ELECTRO-

Albright and Wilson (Mfg.), Ltd.
Atlas Plating Works, Ltd.
Ericsson Telephones, Ltd.
Metachemical Processes, Ltd.
Stuart (London), Ltd., Robert
Technical Platings, Ltd.
Turner Electrical Instruments, Ltd., Ernest
Western Manufacturing (Reading), Ltd.

PLATING EQUIPMENT, ELECTRO-

Sheffield Smelting Co., Ltd., The

PLUGS, SPARKING AND IGNITER

K.L.G. Sparking Plugs, Ltd.
Lodge Plugs, Ltd.

PLYWOOD

Jablo Plastics Industries, Ltd.
Mallinson and Sons, Ltd., William

PNEUMATIC SYSTEMS

Aircraft Materials, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Headland Engineering Developments, Ltd.
Hymatic Engineering Co., Ltd., The
Kidde Co., Ltd., The Walter
Plessey Co., Ltd., The
Turner Manufacturing Co., Ltd.

PRESSES, POWER

Fawcett, Preston and Co., Ltd.
Western Manufacturing (Reading), Ltd.

PRESSURE VESSELS

Birkett, Billington and Newton, Ltd., T. M.
Booth and Sons (Bolton), Ltd., John
Bristol Aerojet, Ltd.
Chesterfield Tube Co., Ltd., The
Delaney Gallay, Ltd.
Distington Engineering Co., Ltd.
Dunlop Rubber Co., Ltd.
Firth and John Brown, Ltd., Thos.
Gordon and Co.
Hadfields, Ltd.
Harvey and Co. (London), Ltd., G. A.
Headland Engineering Developments, Ltd.
Hercules Engineering Co., Ltd., The
Hymatic Engineering Co., Ltd., The
Marston Excelsior, Ltd.
Reynolds Tube Co., Ltd.
Siebe Gorman and Co., Ltd.
United Steel Companies, Ltd., The
Williams and James (Engineers), Ltd.

PRESSURIZATION EQUIPMENT—

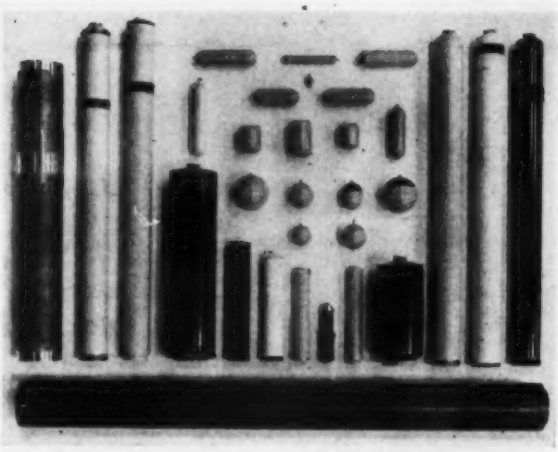
see Air conditioning

PRESSWORK

Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Attewell and Sons, Ltd., B.
Aviation Traders (Engineering), Ltd.
Bell Precision Engineering Co., Ltd.
Bramah and Co., Ltd., J. R.
Brown Bros. (Aircraft), Ltd.
Clifford Products, Ltd.
Coopers Mechanical Joints, Ltd.
Corner and Co., Ltd., G.
Cornercroft, Ltd.
Duvall and Sons, Ltd., S.
Delaney Gallay, Ltd.
Electro Mechanisms, Ltd.
Ericsson Telephones, Ltd.
Field Aircraft Services, Ltd.
Henderson Safety Tank Co., Ltd., The
Hercules Engineering Co., Ltd., The
Hunting Aircraft, Ltd.
Jablo Plastics Industries, Ltd.
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Miles, Ltd., F. G.
Plessey Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Portsmouth Aviation, Ltd.
Ratcliffe (Rochdale), Ltd., F. S.
Riley, Ltd., Robert
Sankey and Sons, Ltd., Joseph
Saunders-Roe (Anglesey), Ltd.
Steel Stampings, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Tempered Spring Co., Ltd., The
Vernons Industries, Ltd.
Villiers (Tool Developments), Ltd.
Western Manufacturing (Reading), Ltd.

PRINTED CIRCUITS

Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Bakelite, Ltd.
Belling and Lee, Ltd.



Typical rocket-motor tubes and pressure vessels by Bristol Aerojet

Cossor Instruments, Ltd.
Cossor Radar and Electronics, Ltd.
de Havilland Propellers, Ltd.
English Electric Aviation, Ltd.
Ericsson Telephones, Ltd.
Ferranti, Ltd.
Hunting Engineering, Ltd.
Microcell, Ltd.
Miles Electronics, Ltd.
Newmark, Ltd., Louis
Plessey Co., Ltd., The
Siemens Edison Swan, Ltd.
Technograph Electronic Products, Ltd.
Ultra Electric, Ltd.

PROPELLERS AND ASSOCIATED EQUIPMENT

Airscrew Co. and Jicwood, Ltd., The
de Havilland Propellers, Ltd.
Fairey Aviation, Ltd.
Hordern-Richmond, Ltd.
Rotol, Ltd.
Sankey and Sons, Ltd., Joseph

PROTECTIVE PROCESSES (other than aircraft finishes)

Albright and Wilson (Mfg.), Ltd.
B.B. Chemical Co., Ltd.
Brand and Co., Ltd., R. A.
Corner and Co., Ltd., G.
Harvey and Co. (London), Ltd., G. A.
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Metachemical Processes, Ltd.
Pyrene Co., Ltd., The
Stuart (London), Ltd., Robert
Valay Industries, Ltd.

PUBLIC-ADDRESS EQUIPMENT, AIRBORNE

Murphy Radio, Ltd. (Electronics Division)
Philips Electrical, Ltd.
Redifon, Ltd.
Savage, Ltd., W. Bryan
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.
Trix Electrical Co., Ltd., The
Ultra Electric, Ltd.
W.S. Electronics

PUBLIC-ADDRESS EQUIPMENT, GROUND

British Thomson-Houston Co., Ltd.
E.M.I. Electronics, Ltd.
Ericsson Telephones, Ltd.
General Electric Co., Ltd., The
Philips Electrical, Ltd.
Pye Telecommunications, Ltd.
Redifon, Ltd.
Savage, Ltd., W. Bryan
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.
Trix Electrical Co., Ltd., The
W.S. Electronics

PUBLICATIONS, TECHNICAL AND GENERAL

Hunting Aerosurveys, Ltd.
Iliffe and Sons, Ltd.
International Aeradio, Ltd.
Pitman and Sons, Ltd., Sir Isaac
Putnam and Co., Ltd.
Secker and Warburg, Martin
Stuart, C. G. B.
Technical Publications and Supplies, Ltd.

PUMPS, AIR PRESSURE AND VACUUM

Dunlop Rubber Co., Ltd.
Godfrey and Partners, Ltd., Sir George
Headland Engineering Developments, Ltd.
Hercules Engineering Co., Ltd., The
Hymatic Engineering Co., Ltd., The
Plessey Co., Ltd., The
Pulsometer Engineering Co., Ltd.
Rotax, Ltd.
Turner Manufacturing Co., Ltd.
Williams and James (Engineers), Ltd.

PUMPS, FUEL AND OIL

Amal, Ltd.
Dowty Fuel Systems, Ltd.
Fairey Aviation, Ltd.
Girdlestone Pumps, Ltd.
Gordon and Co.
Hobson, Ltd., H. M.
Lucas (Gas Turbine Equipment), Ltd., Joseph

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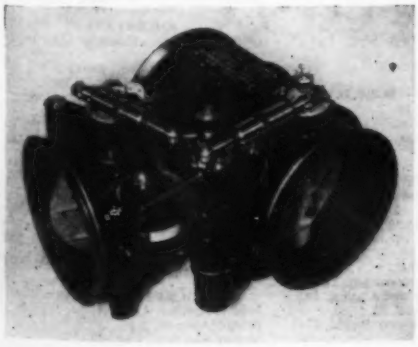
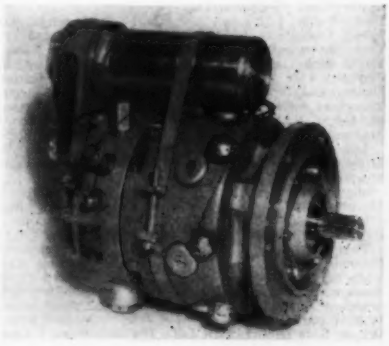


(Left) Pressurization feed-back valve, Type FBV-6, by Sir George Godfrey and Partners, Ltd.

(Right) Integral, Ltd., hydraulic pump, Type 180 Mk 43



Marconi AD.722 sub-miniature A.D.F. in a Super Aero 45. The control panel is immediately above the throttle levers, and the relative-bearing indicator is the small dial near the pilot's hand

ANCILLARY INDUSTRY 1959...

Plessey Co., Ltd., The
Pulsometer Engineering Co., Ltd.
SPE Co., Ltd.
Wayne Tank and Pump Co., Ltd.
Zwicky, Ltd.

PUMPS, HYDRAULIC

Boulton Paul Aircraft, Ltd.
Dowty Equipment, Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Fawcett, Preston and Co., Ltd.
Girdlestone Pumps, Ltd.
Gordon and Co.
Hobson, Ltd., H. M.
Integral, Ltd.
Lockheed Precision Products, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Plessey Co., Ltd., The
Pulsometer Engineering Co., Ltd.
Rotol, Ltd.
Skyhi, Ltd.
Sperry Gyroscope Co., Ltd.
Turner Manufacturing Co., Ltd.
Weyburn Engineering Co., Ltd., The
Williams and James (Engineers), Ltd.
Wilmot Breeden, Ltd.

PYROTECHNICS

Graviner Colnbrook
Schermuly Pistol Rocket Apparatus, Ltd., The

RADAR EQUIPMENT AND COMPONENTS

Amphenol (Great Britain), Ltd.
B.M.B. (Sales), Ltd.
Belling and Lee, Ltd.
Bradley, Ltd., G. and E.
Burndept, Ltd.
C. and N. (Electrical), Ltd.
Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
de Havilland Propellers, Ltd.
Decca Radar, Ltd.
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Elliott Bros. (London), Ltd.
Ferranti, Ltd.
General Electric Co., Ltd., The
Lancefield Aircraft Components, Ltd.
McMichael Radio, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Miles Structural Plastics, Ltd.
Morfax, Ltd.
Mullard Equipment, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Page Engineering (Sunbury on Thames), Ltd.
Plannair, Ltd.
Redwing, Ltd.
Sanders (Electronics), Ltd., W. H.
Standard Telephones and Cables, Ltd.
W.S. Electronics
Wayne Kerr Laboratories, Ltd., The

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Amplivox, Ltd.
Anticoustic Co., The
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Belling and Lee, Ltd.
Bradley, Ltd., G. and E.
Burndept, Ltd.
C. and N. (Electrical), Ltd.
Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
Decca Navigator Co., Ltd., The
Ekco Electronics, Ltd.
Elliott Bros. (London), Ltd.
General Electric Co., Ltd., The
Gloster Technical Developments Division
International Aeradio, Ltd.
McMichael Radio, Ltd.
Mullard Equipment, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Page Engineering (Sunbury on Thames), Ltd.
Plannair, Ltd.
Plessey Co., Ltd., The
Pye Telecommunications, Ltd.
Racal Engineering, Ltd.
Redifon, Ltd.
Salford Electrical Instruments, Ltd.
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.
Ultra Electric, Ltd.
W.S. Electronics
Wayne Kerr Laboratories, Ltd., The

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Burndept, Ltd.
Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
Decca Navigator Co., Ltd., The
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Elliott Bros. (London), Ltd.
General Electric Co., Ltd., The
McMichael Radio, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Mullard Equipment, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Plessey Co., Ltd., The
Pye Telecommunications, Ltd.
Redifon, Ltd.
Salford Electrical Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Ultra Electric, Ltd.
W.S. Electronics
Z and I Aero Services, Ltd.

RADIO AND RADAR INSTALLATIONS, PLANNING AND SUPPLY OF

Cole, Ltd., E. K.
Cossor Radar and Electronics, Ltd.
Curran, Ltd., John
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Field Aircraft Services, Ltd.
General Electric Co., Ltd., The
International Aeradio, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Mullard Equipment, Ltd.
Plessey Co., Ltd., The
Pye Telecommunications, Ltd.
Racal Engineering, Ltd.
Redifon, Ltd.
Sanders (Electronics), Ltd., W. H.
Standard Telephones and Cables, Ltd.
W.S. Electronics
Z and I Aero Services, Ltd.

RADIOGRAPHY AND X-RAY EQUIPMENT

Burndept, Ltd.
General Electric Co., Ltd., The
Harvey and Co. (London), Ltd., G. A.
Marconi Instruments, Ltd.
Mullard Equipment, Ltd.
Palmer Aero Products, Ltd.

RADOMES

Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Bristol Aircraft, Ltd.
English Electric Aviation, Ltd.
Fairey Aviation, Ltd.
Fairey Marine, Ltd.
Frankenstein and Sons (Manchester), Ltd., P.
Gloster Aircraft Co., Ltd.
Hercules Engineering Co., Ltd., The
Marconi's Wireless Telegraph Co., Ltd.
Marston Excelsior, Ltd.
Miles Structural Plastics, Ltd.
R.F.D. Co., Ltd.
Wayne Kerr Laboratories, Ltd., The

RECORDERS, SOUND

Dawe Instruments, Ltd.
E.M.I. Electronics, Ltd.
Thermionic Products (Electronics), Ltd.

RECTIFIERS

British Thomson-Houston Co., Ltd., The
Brush Crystal Co., Ltd., The
Ferranti, Ltd.
Mullard, Ltd.
Plessey Co., Ltd., The
Salford Electrical Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Texas Instruments, Ltd.
Westinghouse Brake and Signal Co., Ltd.

REFRACTORY MATERIALS

Bell's Asbestos and Engineering, Ltd.
British Refrasil Co., Ltd., The
Delaney Gallay, Ltd.
Steatite and Porcelain Products, Ltd.
Turner Bros. Asbestos Co., Ltd.

REFUELLERS—see Fuelling equipment

RELAYS, ELECTRICAL

British Thomson-Houston Co., Ltd., The
Cathodeon, Ltd.
Davall and Sons, Ltd., S.
"Diamond H" Switches, Ltd.
Electro-Hydraulics, Ltd.
English Electric Co., Ltd., The
Ericsson Telephones, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Hendrey Relays, Ltd.
Measuring Instruments (Pullin), Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Philips Electrical, Ltd.
Plessey Co., Ltd., The
Pullin and Co., Ltd., R. B.
Salford Electrical Instruments, Ltd.
Sanders (Electronics), Ltd., W. H.
Sangamo Weston, Ltd.
Sciaky Electric Welding Machines, Ltd.
Sheffield Smelting Co., Ltd., The
Siemens Edison Swan, Ltd.
Smiths Aviation Division
Standard Telephones and Cables, Ltd.
Thorn Electrical Industries, Ltd.
Western Manufacturing (Reading), Ltd.

RELEASES, PARACHUTE, DROP-TANK, ETC.

Aircraft Materials, Ltd.
Ferranti Meters, Ltd., Denis
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
M.B. Metals, Ltd.
M.L. Aviation Co., Ltd.
Mechanism, Ltd.
Redwing, Ltd.

REPAIR, AIRFRAME (see also Servicing)

Armstrong Whitworth Aircraft, Ltd Sir W. G.
Aviation Traders (Engineering), Ltd.
Brooklands Aviation, Ltd.
Fairey Aviation, Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Miles, Ltd., F. G.
Portsmouth Aviation, Ltd.
Samlesbury Engineering, Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
Warden Aviation and Engineering Co.

REPAIR, ENGINE (see also Servicing)

Air Engine Services (U.S.-U.K.), Ltd.
Brooklands Aviation, Ltd.
de Havilland Engine Co., Ltd., The
Field Aircraft Services, Ltd.
Gordon and Co.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Samlesbury Engineering, Ltd.
Scottish Aviation, Ltd.
Warden Aviation and Engineering Co.

RESISTORS

British Thomson-Houston Co., Ltd., The
Fawcett, Preston and Co., Ltd.
Plessey Co., Ltd., The
Standard Telephones and Cables, Ltd.
Technograph Electronic Products, Ltd.
Thorn Electrical Industries, Ltd.

RHEOSTATS

British Thomson-Houston Co., Ltd., The
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Salford Electrical Instruments, Ltd.

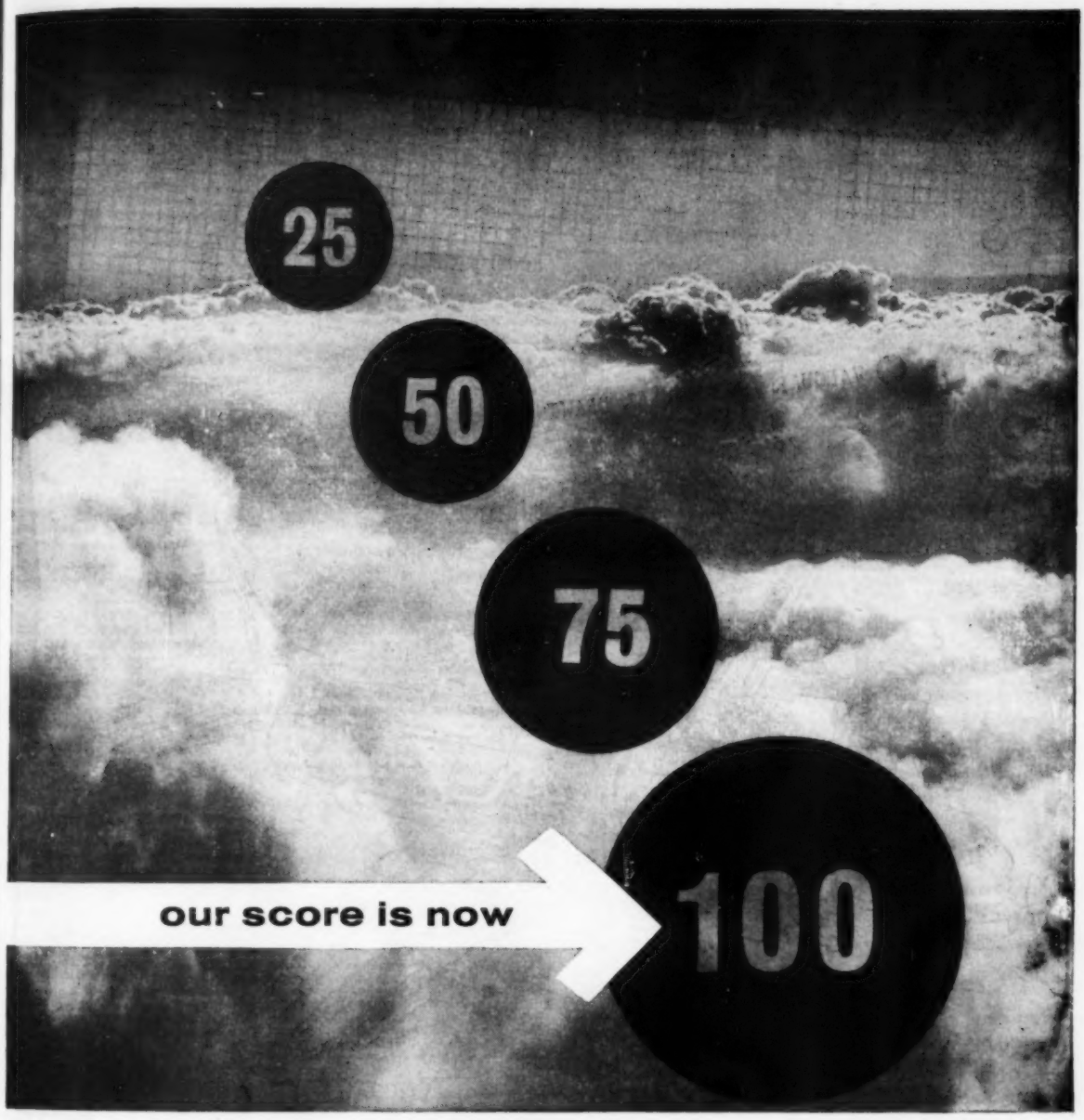
RIVETING EQUIPMENT

Aircraft Materials, Ltd.
Atlas Copco (Great Britain), Ltd.
Aviation Developments, Ltd.
Bardolph and Partners, Ltd., J. F.
Brown Bros. (Aircraft), Ltd.
Headland Engineering Developments, Ltd.

RIVETS—see A.G.S. parts

ROCKET BOOSTERS

Bristol Aerojet, Ltd.
Bristol Aircraft, Ltd.
Napier and Son, Ltd., D.



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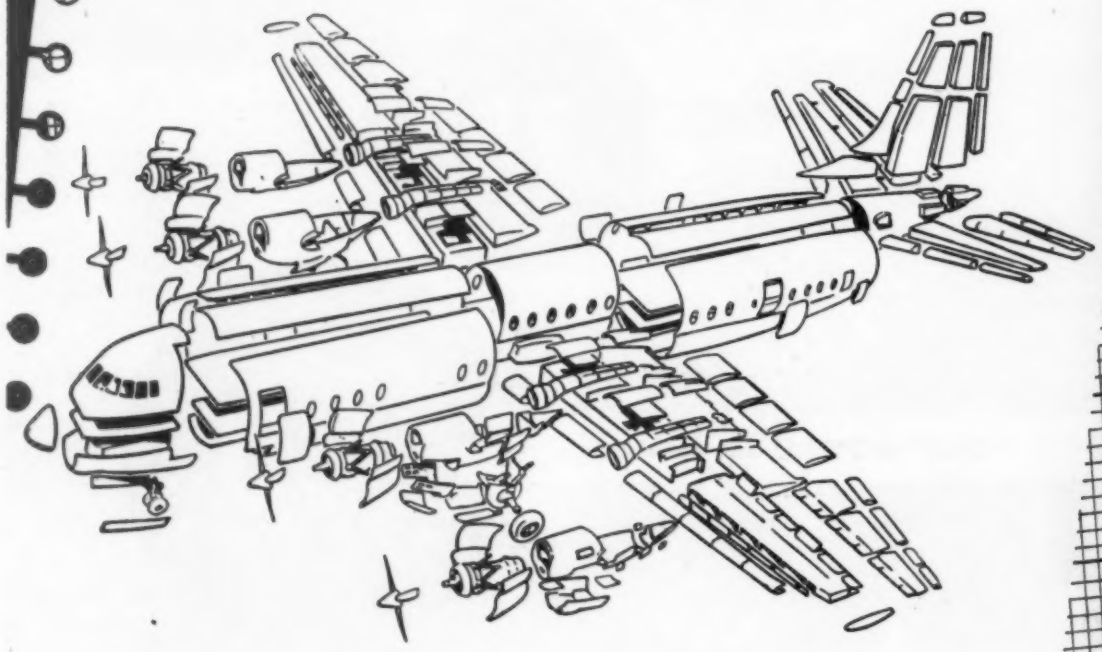

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General Electric Co., Ltd., The

RUBBER, EXPANDED
Bell's Asbestos and Engineering, Ltd.
Boorn and Co., Ltd., Thomas
Dunlop Rubber Co., Ltd.
Kautex, Ltd.
Palmer Aero Products, Ltd.
Precision Rubbers, Ltd.
Ward, Brooke and Co., Ltd.

RUBBER, GENERAL AND MECHANICAL
(including synthetic rubbers and bonded components)
Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Boorn and Co., Ltd., Thomas
Dowty Seals, Ltd.
Dunlop Rubber Co., Ltd.
Fireproof Tanks, Ltd.
Hall and Hall, Ltd.
Imperial Chemical Industries, Ltd.
Kautex, Ltd.
Lancefield Aircraft Components, Ltd.
Long and Hambly, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Precision Rubbers, Ltd.
St. Helens Cable and Rubber Co., Ltd.
Super Oil Seals and Gaskets, Ltd.
Tempered Spring Co., Ltd., The
Trist and Co., Ltd., Ronald
Walker and Co., Ltd., James

RUST REMOVERS AND INHIBITORS
(see also Corrosion, Protective processes, etc.)
B.B. Chemical Co., Ltd.
Imperial Chemical Industries, Ltd.
Kenilworth Manufacturing Co., Ltd., The
Laporte Chemicals, Ltd.
Pyrene Co., Ltd., The
Shell-Mex and BP, Ltd.

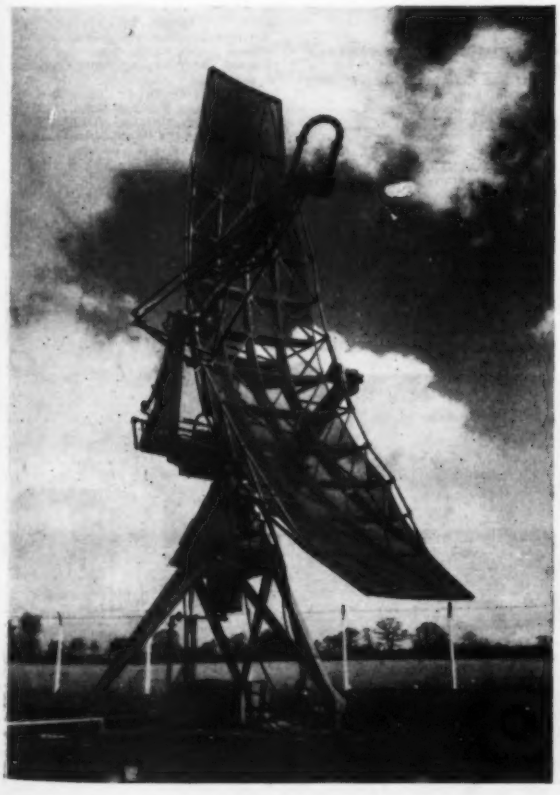
Ferranti Airpass radar fire-control unit being loaded into the nose of a Canberra used for trial and demonstration of the equipment, which is now in production for the Lightning interceptor

Stuart (London), Ltd., Robert
Valay Industries, Ltd.
Wakefield and Co., Ltd., C. C.
Wakefield-Dick Industrial Oils, Ltd.

SAFETY EQUIPMENT—see Life-saving equipment

SALVAGE EQUIPMENT, AIRCRAFT
Aviation Traders (Engineering), Ltd.
Bell's Asbestos and Engineering, Ltd.

Decca HF 200 radar, to be exhibited at Farnborough



SALVAGE OF AIRCRAFT, ETC.
Aviation Traders (Engineering), Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.

SCRAP, COLLECTION AND DISPOSAL OF
Coley and Son (Hounslow), Ltd., R. J.

SCREWS—see A.G.S. parts

SEALANTS
B.B. Chemical Co., Ltd.
British Paints, Ltd.
Kane, Ltd., Douglas
Kenilworth Manufacturing Co., Ltd., The
Trist and Co., Ltd., Ronald
Wellworthy, Ltd.

SEALANTS, RUNWAY JOINTING
B.B. Chemical Co., Ltd.
British Paints, Ltd.

SEALS, MECHANICAL
Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Dowty Seals, Ltd.
Electro-Hydraulics, Ltd.
Flexibox, Ltd.
Hall and Hall, Ltd.
Super Oil Seals and Gaskets, Ltd.
Trist and Co., Ltd., Ronald
Walker and Co., Ltd., James
Wellworthy, Ltd.

SEATS, AIRCRAFT
Aircraft Furnishing, Ltd.
Aviation Traders (Engineering), Ltd.
de Havilland Aircraft Co., Ltd., The
Fairey Aviation, Ltd.
Fairey Marine, Ltd.
Field Aircraft Services, Ltd.
Flight Equipment and Engineering, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
Latex Upholstery, Ltd.
Microcell, Ltd.
Rumbold and Co., Ltd., L. H.
Samlesbury Engineering, Ltd.
Tiltman Langley, Ltd.
Transport Seating, Ltd.
Vickers-Armstrongs (Aircraft), Ltd.

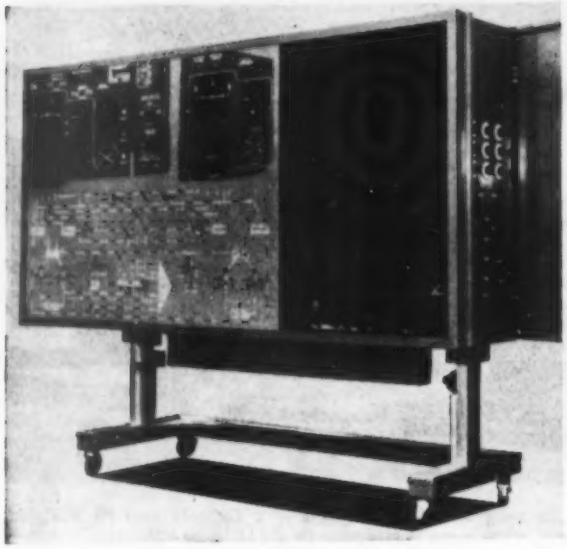
SEATS, EJECTION
Folland Aircraft, Ltd.
M.L. Aviation Co., Ltd.
Martin-Baker Aircraft, Ltd.

SEMICONDUCTORS
British Thomson-Houston Co., Ltd., The
Brush Crystal Co., Ltd., The
English Electric Co., Ltd., The
Ferranti, Ltd.
Gloster Aircraft Co., Ltd.
Imperial Chemical Industries, Ltd.
Mining and Chemical Products, Ltd.
Mullard, Ltd.
Salford Electrical Instruments, Ltd.
Semiconductors, Ltd.
Siemens Edison Swan, Ltd.
Standard Telephones and Cables, Ltd.
Texas Instruments, Ltd.
Westinghouse Brake and Signal Co., Ltd.

SERVICING, REPAIR AND OVERHAUL, AIRFRAME
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Aviation Traders (Engineering), Ltd.
Bristol Aircraft, Ltd.
Brooklands Aviation, Ltd.
Derby Aviation, Ltd.
Dundas, Ltd., R. K.
Eagle Aircraft Services, Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Miles, Ltd., F. G.
Portsmouth Aviation, Ltd.
Rollason Aircraft and Engines, Ltd.
Scottish Aviation, Ltd.
Simon Engineering (Midlands), Ltd.
Skyways, Ltd.
Warden Aviation and Engineering Co.

SERVICING, REPAIR AND OVERHAUL, ELECTRONIC
Aerocontacts (Sales), Ltd.
Aviation Traders (Engineering), Ltd.
Brooklands Aviation, Ltd.
Cossor Radar and Electronics, Ltd.
Dundas, Ltd., R. K.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Newmark, Ltd., Louis
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Redifon, Ltd.
Sanders (Electronics), Ltd., W. H.
Scottish Aviation, Ltd.
Solartron Electronic Group, Ltd., The
Ultra Electric, Ltd.
Wayne Kerr Laboratories, Ltd., The
Wynstruments, Ltd.

SERVICING, REPAIR AND OVERHAUL, ELECTRICAL
Aerocontacts (Sales), Ltd.
Aviation Traders (Engineering), Ltd.
Brooklands Aviation, Ltd.
Brown, Ltd., S. G.
Dundas, Ltd., R. K.
Eagle Aircraft Services, Ltd.
Eastern Aero Electrical Services, Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Newmark, Ltd., Louis
Plessey Co., Ltd., The
Portsmouth Aviation, Ltd.
Rotax, Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
Vernons Industries, Ltd.
Western Manufacturing (Reading), Ltd.
Wynstruments, Ltd.



Classroom training aid for Bendix flight system of Boeing 707 (Air Trainers Link, Ltd.)

ANCILLARY INDUSTRY 1959...

SERVICING, REPAIR AND OVERHAUL, ENGINE

Air Engine Services (U.S.-U.K.), Ltd.
Aviation Traders (Engineering), Ltd.
Brooklands Aviation, Ltd.
de Havilland Engine Co., Ltd., The
Delaney Gallay, Ltd.
Dundas, Ltd., R. K.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Gordon and Co.
McAlpine and Sons, Ltd., Sir Robert (Aviation Division)
Plessey Co., Ltd., The
Rollason Aircraft and Engines, Ltd.
Scottish Aviation, Ltd.
Vosper, Ltd.
Warden Aviation and Engineering Co.

SERVICING, REPAIR AND OVERHAUL, INSTRUMENT

Aerocontacts (Sales), Ltd.
Aviation Traders (Engineering), Ltd.
Brown, Ltd., S. G.
Dundas, Ltd., R. K.
Eagle Aircraft Services, Ltd.
Electro Mechanisms, Ltd.
Field Aircraft Services, Ltd.
Flight Refuelling, Ltd.
Mechanism, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Scottish Aviation, Ltd.
Skyways, Ltd.
W.S. Electronics
Walter, Ltd., A. J.
Williamson Manufacturing Co., Ltd.
Wynstruments, Ltd.

SERVO MECHANISMS

Appleby and Ireland, Ltd.
Blackburn Electronics, Ltd.
Boulton Paul Aircraft, Ltd.
Brown, Ltd., S. G.
Consor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
de Havilland Propellers, Ltd.
Dowty Equipment, Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Hobson, Ltd., H. M.
Hunting Engineering, Ltd.
Kelsey, Ltd.
Miles Electronics, Ltd.
Pullin and Co., Ltd., R. D.
Redwing, Ltd.
Rotol, Ltd
Short Bros. and Harland, Ltd.
Sperry Gyroscope Co., Ltd.
Turner Manufacturing Co., Ltd.
Ultra Electric, Ltd.
Vactric (Control Equipment), Ltd.
Wilmot Breeden, Ltd.

SHEET AND PLATE, LIGHT ALLOY

Aluminium Corporation, Ltd.
Birmetals, Ltd.
Booth and Co., Ltd., James
Gordon and Co.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
High Duty Alloys, Ltd.
Morfax, Ltd.
Northern Aluminium Co., Ltd.
Rapp, Ltd., Leo
Western Manufacturing (Reading), Ltd.
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

SHEET METAL WORK—*see* Fabrications

SHIMS

Attewell and Sons, Ltd., B.
Coopers Mechanical Joints, Ltd.

SHOCK ABSORBERS—*see* Mountings

SHUTTERS

Bolton Gate Co., Ltd.
Booth and Sons (Bolton), Ltd., John

SILENCERS

Cementation (Muffelite), Ltd.
Gordon and Co.
Henshall and Sons (Addlestone), Ltd., W.
Vokes, Ltd.

SILICONE PRODUCTS

Avon India Rubber Co., Ltd., The
Bell's Asbestos and Engineering, Ltd.
Dowty Seals, Ltd.
Dunlop Rubber Co., Ltd.
Hall and Hall, Ltd.
Imperial Chemical Industries, Ltd.
Kautex, Ltd.
Long and Hambly, Ltd.
Modern Industrial Finishes, Ltd.
Northern Rubber Co., Ltd., The
Palmer Aero Products, Ltd.
Precision Rubbers, Ltd.
Valay Industries, Ltd.

SIMULATORS, AIRCRAFT

Air Trainers Link, Ltd.
Hobson, Ltd., H. M.
M.L. Aviation Co., Ltd.
Miles Electronics, Ltd.
Redifon, Ltd.
Saunders-Roe, Ltd.
Short Bros. and Harland, Ltd.
Wilmot Breeden, Ltd.

SIMULATORS, RADAR

Air Trainers Link, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Redifon, Ltd.
Solarton Electronic Group, Ltd., The
Ultra Electric, Ltd.

SOLDERING EQUIPMENT AND SOLDER

Adcola Products, Ltd.
Aircraft Materials, Ltd.
Brown Bros. (Aircraft), Ltd.
Light Soldering Developments, Ltd.
Sheffield Smelting Co., Ltd., The
Tiltman Langley, Ltd.

SOLENOIDS

Dowty Nucleonics, Ltd.
Electro-Hydraulics, Ltd.
English Electric Co., Ltd., The
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Plessey Co., Ltd., The
Rotax, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Western Manufacturing (Reading), Ltd.

SOUNDPROOFING MATERIALS

Anticoustic Co., The
Cullum and Co., Ltd., Horace W.
Fibreglass, Ltd.
Jablo Plastics Industries, Ltd.
Rumbold and Co., Ltd., L. A.

SPRAYING EQUIPMENT (FOR PAINTS, ETC.)

Atlas Copco (Great Britain), Ltd.
B.R.D. Co., Ltd.
Headland Engineering Developments, Ltd.

SPRINGS

Cross Manufacturing Co. (1938), Ltd.
Ferranti Meters, Ltd., Denis
Fox and Co., Ltd., Samuel
Ratcliffe (Rochdale), Ltd., F. S.
Riley, Ltd., Robert
Salter and Co., Ltd., Geo.
Tempered Spring Co., Ltd., The
Terry and Sons, Ltd., Herbert
Tungum Co., Ltd., The

STABILIZERS, FLIGHT CONTROL

Gloster Technical Developments Division
Newmark, Ltd., Louis
Sperry Gyroscope Co., Ltd.

STAGINGS, PLATFORMS, ETC., ASSEMBLY AND MAINTENANCE

Aero Controls, Ltd.
Aviation Traders (Engineering), Ltd.
Booth and Sons (Bolton), Ltd., John
Edghill and Co., Ltd., H. W.
Mercury Airfield Equipment, Ltd.
Morfax, Ltd.
Spurling Motor Bodies, Ltd.

STALL-WARNING EQUIPMENT

Kelvin and Hughes (Aviation), Ltd.
Smiths Aviation Division

STANDS, ENGINE, ETC.

Aerocontacts (Ground Equipment), Ltd.
Aviation Traders (Engineering), Ltd.
B.R.D. Co., Ltd.
Curran, Ltd., John
Edghill and Co., Ltd., H. W.
Mercury Airfield Equipment, Ltd.
Morfax, Ltd.
Rollason Aerocessories, Ltd.

STARTERS

(see also Engine starters, Auxiliary power units, Ground power units)

Atlas Copco (Great Britain), Ltd.
Auto Diesels, Ltd.
Blackburn Engines, Ltd.
Brown Construction Equipment, Ltd., David
Davall and Sons, Ltd., S.
de Havilland Engine Co., Ltd., The
Houchin, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Rover Gas Turbines, Ltd.
Venner Accumulators, Ltd.
Vernons Industries, Ltd.
Westinghouse Brake and Signal Co., Ltd.

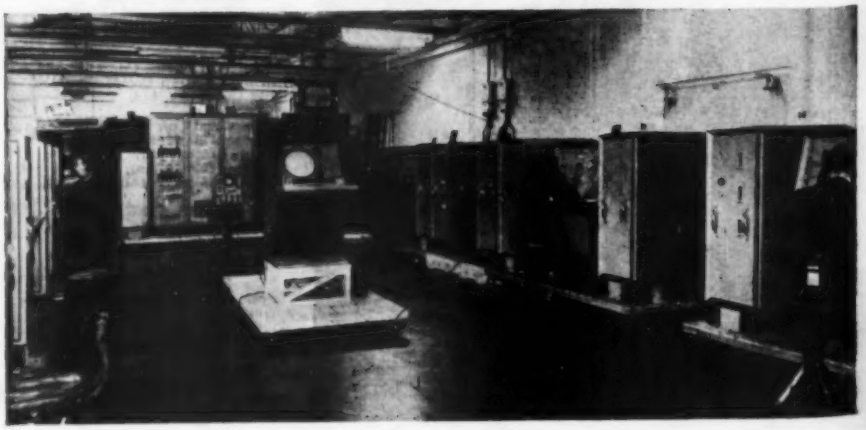
STEEL PLATE

Appleby-Frodingham Steel Co.
Brown Bayley Steels, Ltd.
English Steel Rolling Mills Corporation, Ltd.
Firth and John Brown, Ltd., Thos.
Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Gordon and Co.
Low Moor Alloy Steelworks, Ltd.
United Steel Companies, Ltd., The

STEEL SHEET

Aircraft Materials, Ltd.
Brown Bayley Steels, Ltd.
English Steel Rolling Mills Corporation, Ltd.
Firth and John Brown, Ltd., Thos.
Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Gordon and Co.

A typical 20-target Solartron radar simulator being tested before delivery to a NATO country



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ANCILLARY INDUSTRY 1959...

Habershon and Sons, Ltd., J. J.
Jessop-Saville, Ltd.
Low Moor Alloy Steelworks, Ltd.
Terry and Sons, Ltd., Herbert

STEEL STRUCTURAL SECTIONS
Appleby-Frodingham Steel Co.
Burnley Aircraft Products, Ltd.
Cornercroft, Ltd.
Firth and John Brown, Ltd., Thos.
Gordon and Co.
United Steel Companies, Ltd., The

STEELS, AIRCRAFT
(see also Alloys, ferrous, etc.)
Aircraft Materials, Ltd.
Brown Bayley Steels, Ltd.
Brown Bros. (Aircraft), Ltd.
Carlisle and Co., Ltd., C. G.
English Steel Rolling Mills Corporation, Ltd.
Firth & John Brown, Ltd., Thos.
Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Gordon and Co.
Habershon and Sons, Ltd., J. J.
Hadfields, Ltd.
Jessop-Saville, Ltd.
Kayser, Ellison and Co., Ltd.
Kiveton Park Steel and Wire Works, Ltd.
LR Airsteel, Ltd.
Low Moor Alloy Steelworks, Ltd.
Steel, Peech and Tozer
United Steel Companies, Ltd., The

STEELS, CORROSION-RESISTING
(see also Alloys, etc.)
Aircraft Materials, Ltd.
Brown Bayley Steels, Ltd.
Brown Bros. (Aircraft), Ltd.
Carlisle and Co., Ltd., C. G.
Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Gordon and Co.
Habershon and Sons, Ltd., J. J.
Hadfields, Ltd.
Jessop-Saville, Ltd.
Kayser, Ellison and Co., Ltd.
Kiveton Park Steel and Wire Works, Ltd.
LR Airsteel, Ltd.
Low Moor Alloy Steelworks, Ltd.
United Steel Companies, Ltd., The

STEELS, HEAT-RESISTING
(see also Alloys, etc.)
Brown Bayley Steels, Ltd.
Carlisle and Co., Ltd., C. G.
Firth-Vickers Stainless Steels, Ltd.
Fox and Co., Ltd., Samuel
Gordon and Co.
Hadfields, Ltd.
Jessop-Saville, Ltd.
Kayser, Ellison and Co., Ltd.
Kiveton Park Steel and Wire Works, Ltd.
Low Moor Alloy Steelworks, Ltd.
United Steel Companies, Ltd., The

STEPS, AIRCRAFT PASSENGER
Aviation Traders (Engineering), Ltd.
Edghill and Co., Ltd., H. W.
Gordon and Co.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Morfax, Ltd.

STORAGE EQUIPMENT
Brown Bros. (Aircraft), Ltd.
Brown, Ltd., N. C.
C. and N. (Electrical), Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Rubery Owen and Co., Ltd.
Steel Equipment, Ltd.

SWEEPERS, RUNWAY
General Electric Co., Ltd., The
Lewin Road Sweepers, Ltd.
Zwicky, Ltd.

SWITCHES, AUTOMATIC AND SPECIAL-PURPOSE
Amphenol (Great Britain), Ltd.
British Thomson-Houston Co., Ltd., The
Davall and Sons, Ltd., S.
Dunlop Rubber Co., Ltd.
English Electric Co., Ltd., The
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
Irving Air Chute of Great Britain, Ltd.
Munro, Ltd., R. W.
Page Engineering (Sunbury on Thames), Ltd.
Rotax, Ltd.
Technograph Electronic Products, Ltd.
Teddington Aircraft Controls, Ltd.
Thermal Control Co., Ltd.
Vactric (Control Equipment), Ltd.
Venner, Ltd.
Wynstruments, Ltd.

SWITCHES, ELECTRICAL
Bosch, Ltd.
British Thomson-Houston Co., Ltd., The
C. W. C. Equipment, Ltd.
C. and N. (Electrical), Ltd.
Davall and Sons, Ltd., S.
"Diamond H" Switches, Ltd.
Dowty Nucleonics, Ltd.
Dunlop Rubber Co., Ltd.
Eastern Aero Electrical Services, Ltd.
English Electric Co., Ltd., The
General Electric Co., Ltd., The
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
Honeywell Controls, Ltd.
M. B. Metals, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Smart and Brown (Machine Tools), Ltd.
Rotax, Ltd.
Technograph Electronic Products, Ltd.
Thermal Control Co., Ltd.
Venner, Ltd.
W. S. Electronics
Wynstruments, Ltd.

TABLEWARE, AIRLINER
Aerogalley
Attewell and Sons, Ltd., B.
Delaney Gallay, Ltd.

TAKE-OFF AIDS (ROCKET BOOSTERS, ETC.)
Air Trainers Link, Ltd.
Bristol Aerojet, Ltd.

TANKS, DROP
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Bramah and Co., Ltd., J. R.
Bristol Aircraft, Ltd.
Burnley Aircraft Products, Ltd.
Corner and Co., Ltd., G.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Miles, Ltd., F. G.
Miles Structural Plastics, Ltd.
Samlesbury Engineering, Ltd.

TANKS, FUEL AND OIL
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Bramah and Co., Ltd., J. R.
Burnley Aircraft Products, Ltd.
Corner and Co., Ltd., G.
Delaney Gallay, Ltd.
Fireproof Tanks, Ltd.
Harvey and Co. (London), Ltd., G. A.
Henshall and Sons (Addlestone), Ltd., W.
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Rubery Owen and Co., Ltd.
Samlesbury Engineering, Ltd.
Vosper, Ltd.

TAPE, RECORDING
Direct Photographic Supply Co.
E. M. I. Electronics, Ltd.
Flexonics, Ltd.
Minnesota Mining and Manufacturing Co., Ltd.
Philips Electrical, Ltd.

TAPES, MASKING, ETC.
Aircraft Materials, Ltd.
Brown Bros. (Aircraft), Ltd.
Minnesota Mining and Manufacturing Co., Ltd.

TAPES, HEATING
Godden (Cheltenham), Ltd., M. H.
Telegraph Construction and Maintenance Co., Ltd., The

TAPES, IDENTIFICATION
Aircraft Materials, Ltd.
Minnesota Mining and Manufacturing Co., Ltd.

TAPES, INSULATING
Aircraft Materials, Ltd.
Bell's Asbestos and Engineering, Ltd.
British Insulated Callender's Cables, Ltd.

Environmental testing for the industry: the shock and vibration testing laboratory of Cementation (Muffelite), Ltd.

Brown Bros. (Aircraft), Ltd.
Fibreglass, Ltd.
Minnesota Mining and Manufacturing Co., Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Turner Bros. Asbestos Co., Ltd.

TAPES, PROTECTIVE
Bell's Asbestos and Engineering, Ltd.
Minnesota Mining and Manufacturing Co., Ltd.

TARGETS
(see Training equipment, armament)

TELEMETRY EQUIPMENT
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Burndept, Ltd.
Davall and Sons, Ltd., S.
Dobbie McInnes, Ltd.
E.M.I. Electronics, Ltd.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Gloster Technical Developments Division
Graseby Instruments, Ltd.
Hendrey Relays, Ltd.
McMichael Radio, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Plessey Co., Ltd., The
Redifon, Ltd.
Saunders-Roe, Ltd.
Solartron Electronic Group, Ltd., The
Standard Telephones and Cables, Ltd.
Vactric (Control Equipment), Ltd.
W.S. Electronics

TEMPERATURE-SENSITIVE EQUIPMENT
Davall and Sons, Ltd., S.
Gloster Aircraft Co., Ltd.
Graviner Coinbrook
Lucas (Gas Turbine Equipment), Ltd., Joseph
Negretti and Zambra, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Sangamo Weston, Ltd.
Short and Mason, Ltd.
Stone and Co. (Deptford), Ltd., J.
Teddington Aircraft Controls, Ltd.
Ultra Electric, Ltd.
Wayne Kerr Laboratories, Ltd., The
Western Manufacturing (Reading), Ltd.

TERMINALS
Aircraft Materials, Ltd.
Belling and Lee, Ltd.
Brown Bros. (Aircraft), Ltd.
C.W.C. Equipment, Ltd.
Hellermann, Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Steatite and Porcelain Products, Ltd.
Thermal Control Co., Ltd.
Ward, Brooke and Co., Ltd.
Wynstruments, Ltd.

TEST EQUIPMENT, AERODYNAMIC
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Flexonics, Ltd.
Gordon and Co.
Morfax, Ltd.
SFIM (Great Britain), Ltd.

TEST EQUIPMENT, ELECTRICAL AND ELECTRONIC
Airmed, Ltd.
Armstrong Whitworth Aircraft, Ltd., Sir W. G.
Avo, Ltd.
Bell Precision Engineering Co., Ltd.
Blackburn Electronics, Ltd
Boulton Paul Aircraft, Ltd.
Bradley, Ltd., G. and E.
Bryans Aeroquipment, Ltd.
Burndept, Ltd.
C. and N. (Electrical), Ltd.
Cole, Ltd., E. K.
Cossor Instruments, Ltd.
Cossor Radar and Electronics, Ltd.
Dawe Instruments, Ltd.
de Havilland Propellers, Ltd.
Decca Radar, Ltd.
Dobbie McInnes, Ltd.
Dowty Nucleonics, Ltd.
E.M.I. Electronics, Ltd.
Ekco Electronics, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
Field Aircraft Services, Ltd.
Firth Cleveland Instruments, Ltd.
Flexonics, Ltd.
General Electric Co., Ltd., The
Gloster Aircraft, Ltd.
Gloster Technical Developments Division
Goodmans Industries, Ltd.
Gordon and Co.
Graseby Instruments, Ltd.
Grundy and Partners, Ltd.
Honeywell Controls, Ltd.
Hunting Engineering, Ltd.
M.L. Aviation Co., Ltd.
Marconi Instruments, Ltd.
Marconi's Wireless Telegraph Co., Ltd.
Measuring Instruments (Pullin), Ltd.
Microcell, Ltd.
Miles Electronics, Ltd.
Mullard Equipment, Ltd.
Murphy Radio, Ltd. (Electronics Division)
Newmark, Ltd., Louis
Page Engineering (Sunbury on Thames), Ltd.
Plessey Co., Ltd., The
Quality Bearings, Ltd.
Racal Engineering, Ltd.
Rotax, Ltd.

Continued overleaf

ADDRESSES OF COMPANIES: pages xx - xxvi

In Dunlop Aviation Division's test-house: an aircraft tyre is subjected to an inclined-plane crushing test

ANCILLARY INDUSTRY 1959 . .

Salford Electrical Instruments, Ltd.
Sanders (Electronics), Ltd., W. H.
Sangamo Weston, Ltd.
Saunders-Roe, Ltd.
Savage, Ltd., W. Bryan
Sciaky Electric Welding Machines, Ltd.
SFIM (Great Britain), Ltd.
Short Bros. and Harland, Ltd.
Solartron Electronic Group, Ltd., The
Solus-Schall, Ltd.
Southern Instruments, Ltd.
Standard Telephones and Cables, Ltd.
Stewart Aeronautical Supply Co., Ltd.
Thorn Electrical Industries, Ltd.
Tiltman Langley, Ltd.
Turner Electrical Instruments, Ltd., Ernest
Ultra Electric, Ltd.
Vernons Industries, Ltd.
W.S. Electronics
Wayne Kerr Laboratories, Ltd., The
Williamson Manufacturing Co., Ltd.

TEST EQUIPMENT, FUEL

Bryans Aeroquipment, Ltd.
Flight Refuelling, Ltd.
English Electric Aviation, Ltd.
Gordon and Co.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Morfax, Ltd.
Wynstruments, Ltd.

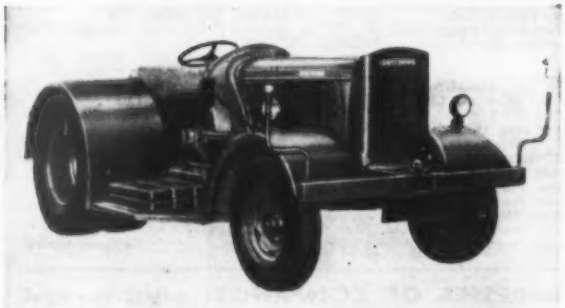
TEST EQUIPMENT, HYDRAULIC

Bell Precision Engineering Co., Ltd.
Bryans Aeroquipment, Ltd.
Cossor Instruments, Ltd.
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
English Electric Aviation, Ltd.
Ferranti Meters, Ltd., Denis
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Gordon and Co.
HML (Engineering), Ltd.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
Integral, Ltd.
Lucas (Gas Turbine Equipment), Ltd., Joseph
Miles Electronics, Ltd.
Palmer Aero Products, Ltd.
SFIM (Great Britain), Ltd.
Tiltman Langley, Ltd.
Turner Manufacturing Co., Ltd.
Western Manufacturing (Reading), Ltd.
Wilmot Breeden, Ltd.

TEST EQUIPMENT, INSTRUMENT

Aerocontacts (Ground Equipment), Ltd.
Avo, Ltd.
Blackburn Electronics, Ltd.
Bryans Aeroquipment, Ltd.
Cossor Instruments, Ltd.
Davall and Sons, Ltd., S.
Dawe Instruments, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Ericsson Telephones, Ltd.
Ferranti, Ltd.
Field Aircraft Services, Ltd.
Firth Cleveland Instruments, Ltd.
Flexonics, Ltd.
Gordon and Co.
Graseby Instruments, Ltd.
Grundy and Partners, Ltd.
Hobson, Ltd., H. M.
Measuring Instruments (Pullin), Ltd.
Mechanism, Ltd
Munro, Ltd., R. W.
Negretti and Zambra, Ltd.
Page Engineering (Sunbury on Thames), Ltd.
Palmer Aero Products, Ltd.
Reid and Sigrist, Ltd.
Rollason Aerocessories, Ltd.
Salford Electrical Instruments, Ltd.
Sanders (Electronics), Ltd., W. H.
Sangamo Weston, Ltd.
SFIM (Great Britain), Ltd.
Short and Mason, Ltd.
Solartron Electronic Group, Ltd., The
Tiltman Langley, Ltd.
Turner Electrical Instruments, Ltd., Ernest
W.S. Electronics
Wayne Kerr Laboratories, Ltd., The
Z and I Aero Services, Ltd.

David Brown Turbo-Taskmaster aircraft tractor



TEST EQUIPMENT, LABORATORY

Avo, Ltd.
Blackburn Electronics, Ltd.
Boulton Paul Aircraft, Ltd.
Bradley, Ltd., G. and E.
Bryans Aeroquipment, Ltd.
Burndept, Ltd.
Cossor Instruments, Ltd.
Dawe Instruments, Ltd.
E.M.I. Electronics, Ltd.
English Electric Aviation, Ltd.
Ericsson Telephones, Ltd.
Fairey Air Surveys, Ltd.
Fairey Aviation, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Goodmans Industries, Ltd.
Graseby Instruments, Ltd.
Grundy and Partners, Ltd.
Hendrey Relays, Ltd.
Hercules Engineering Co., Ltd., The
High-Pressure Components, Ltd.
Hunting Aerosurveys, Ltd.
Rollason Aerocessories, Ltd.
Rover Gas Turbines, Ltd.
Salford Electrical Instruments, Ltd.
Sanders (Electronics), Ltd., W. H.
SFIM (Great Britain), Ltd.
Short and Mason, Ltd.
W.S. Electronics
Wayne Kerr Laboratories, Ltd.
Z and I Aero Services, Ltd.

TEST EQUIPMENT, MECHANICAL

Aircraft Materials, Ltd.
Bell Precision Engineering Co., Ltd.
Cementation (Muffelite), Ltd.
Electro-Hydraulics, Ltd.
Electro Mechanisms, Ltd.
English Electric Aviation, Ltd.
Fairey Air Surveys, Ltd.
Ferranti Meters, Ltd., Denis
Gordon and Co.
Goulder and Sons, Ltd., J.
Graseby Instruments, Ltd.
Heenan and Froude, Ltd.
Hercules Engineering Co., Ltd., The
King Aircraft Corporation
Miles, Ltd., F. G.
Miles Electronics, Ltd.
Morfax, Ltd.
Rollason Aerocessories, Ltd.
Rover Gas Turbines, Ltd.
SFIM (Great Britain), Ltd.
Short Bros. and Harland, Ltd.
Teleflex Products, Ltd.
Tiltman Langley, Ltd.
Torquemeters, Ltd.
Wayne Kerr Laboratories, Ltd., The
Western Manufacturing (Reading), Ltd.

TEST EQUIPMENT, METALLURGICAL

Aircraft Materials, Ltd.
B.R.D. Co., Ltd.
English Electric Aviation, Ltd.
Sciaky Electric Welding Machines, Ltd.
Tiltman Langley, Ltd.

TEST EQUIPMENT, PNEUMATIC

Aircraft Materials, Ltd.
Bell Precision Engineering Co., Ltd.
Bryans Aeroquipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
English Electric Aviation, Ltd.
Gloster Aircraft Co., Ltd.
Gordon and Co.
Headland Engineering Developments, Ltd.
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
Short and Mason, Ltd.
Turner Manufacturing Co., Ltd.
Western Manufacturing (Reading), Ltd.
Williams and James (Engineers), Ltd.

TEST-BED INSTALLATIONS, COMPLETE

Cullum Detuners, Ltd.
Curran, Ltd., John
Gordon and Co.
Heenan and Froude, Ltd.
Hercules Engineering Co., Ltd., The
Morfax, Ltd.

THREAD

Bell's Asbestos and Engineering, Ltd.
Brown Bros. (Aircraft), Ltd.

THREAD INSERTS

Cross Manufacturing Co. (1938), Ltd.
Guest, Keen and Nettlefolds (Midlands), Ltd.
Kane, Ltd., Douglas

THRUST-MEASURING EQUIPMENT

Curran, Ltd., John
Gordon and Co.
Heenan and Froude, Ltd.
Mechanism, Ltd.
Savage, Ltd., W. Bryan
Solartron Electronic Group, Ltd., The

TIMEKEEPING EQUIPMENT

Ericsson Telephones, Ltd.
Graseby Instruments, Ltd.
Venner, Ltd.

TIMING DEVICES

Armstrong Whitworth Aircraft, Ltd., Sir W. G.
British Thomson-Houston Co., Ltd., The
Davall and Sons, Ltd., S.
Ericsson Telephones, Ltd.
Ferranti Meters, Ltd., Denis
Graseby Instruments, Ltd.
Rotax, Ltd.
Sciaky Electric Welding Machines, Ltd.
SFIM (Great Britain), Ltd.
Short and Mason, Ltd.
Teddington Aircraft Controls, Ltd.
Venner, Ltd.

TITANIUM

Accles and Pollock, Ltd.
Imperial Chemical Industries, Ltd.
Jessop-Saville, Ltd.
Titanium Metal and Alloys, Ltd.

TOE-STRAPS, CONTROL

Aero Controls, Ltd.
Palmer Aero Products, Ltd.

TOILET EQUIPMENT, AIRCRAFT

Delaney Gallay, Ltd.
Edghill and Co., Ltd., H. W.
Henshall and Sons (Addlestone), Ltd., W.
Jenks Bros., Ltd.
Parnall and Co., Ltd., George
Templewood Hawksley, Ltd.

TOOLS, CUTTING

B.R.D. Co., Ltd.
English Steel Tool Corporation, Ltd.
Fairey Aviation, Ltd.
Harolds Gauges, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Telegraph Construction and Maintenance Co., Ltd., The

TOOLS, ENGINEERS' HAND

Atlas Copco (Great Britain), Ltd.
B.R.D. Co., Ltd.
English Steel Tool Corporation, Ltd.
Erith Engineering (Leicester), Ltd.
Headland Engineering Developments, Ltd.
Jenks Bros. Ltd.
Kane, Ltd., Douglas
M.H.H. Engineering Co., Ltd.
Rawlplug Co., Ltd., The
Simmonds Aerocessories, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The

TOOLS, FORM

Aerolex, Ltd.
B.R.D. Co., Ltd.
English Steel Tool Corporation, Ltd.
Harolds Gauges, Ltd.
Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hordern-Richmond, Ltd.
Mollart Engineering Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Samlesbury Engineering, Ltd.
Walker (Architectural Decorations), Ltd., James
Woodside Die Sinking Co., Ltd.

TOOLS, MACHINE

B.R.D. Co., Ltd.
Fairey Aviation, Ltd.
Gear Grinding Co., Ltd., The
Mollart Engineering Co., Ltd., The
Sciaky Electric Welding Machines, Ltd.
Smart and Brown (Machine Tools), Ltd.
Woodside Die Sinking Co., Ltd.

TOOLS, PORTABLE POWER

Aircraft Materials, Ltd.
Atlas Copco (Great Britain), Ltd.
Bosch, Ltd.
Desoutter Bros., Ltd.
Rawlplug Co., Ltd., The
Tungum Co., Ltd., The

TOOLS, PRESS

Aerolex, Ltd.
Amar Tool and Gauge Co., Ltd.
Attewell and Sons, Ltd., B.
Bell Precision Engineering Co., Ltd.
CJC Developments (Portsmouth), Ltd.
Cornercroft, Ltd.
Electro Mechanisms, Ltd.
Erith Engineering (Leicester), Ltd.
Harolds Gauges, Ltd.

Henderson Safety Tank Co., Ltd., The
Henshall and Sons (Addlestone), Ltd., W.
Hordern-Richmond, Ltd.
Porter Prototype Engineering (Birmingham), Ltd.
Redwing, Ltd.
Samlesbury Engineering, Ltd.
Vactric (Precision Tools), Ltd.
Walker (Architectural Decorations), Ltd., James
Ward, Brooke and Co., Ltd.
Woodside Die Sinking Co., Ltd.

TOOLS, RIVETING

Aircraft Materials, Ltd.
Atlas Copco (Great Britain), Ltd.
Aviation Developments, Ltd.
Brown Bros. (Aircraft), Ltd.
Hymatic Engineering Co., Ltd., The

TOOLS, SPECIAL PURPOSE

Acratork Engineering Co., Ltd.
Aircraft Materials, Ltd.,
Aviation Developments, Ltd.
B.R.D. Co. Ltd.
Cornercroft, Ltd.
Cramic Aircraft Components, Ltd.
Desoutter Bros., Ltd.
Brith Engineering (Leicester), Ltd.
Fairey Aviation, Ltd.
Goulder and Sons, Ltd., J.
Harolds Gauges, Ltd.
Headland Engineering Developments, Ltd.
Hellermann, Ltd.
Henshall and Sons (Addlestone), Ltd., W.
Hordern-Richmond, Ltd.
Hunting Aircraft, Ltd.
Kane, Ltd., Douglas
M.H.H. Engineering Co., Ltd.
Mollart Engineering Co., Ltd., The
Porter Prototype Engineering (Birmingham), Ltd.
Rawlplug Co., Ltd., The
Rotax, Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Vactric (Precision Tools), Ltd.
Walker (Architectural Decorations), Ltd., James
Woodside Die Sinking Co., Ltd.

Firestone "Sky Champion Gear-grip" tyre

TRACTORS, AIRCRAFT
(see also Handling equipment)

Brown Construction Equipment, Ltd., David
Douglas Equipment, Ltd.
Mercury Truck and Tractor Co., Ltd.

TRAINING, AIRCREW

Derby Aviation, Ltd.
Fairey Aviation, Ltd.
Helicopter Sales, Ltd.

TRAINING, TECHNICAL

Cossor Radar and Electronics, Ltd.
International Aeradio, Ltd.

TRAINING EQUIPMENT AIRCREW

Air Trainers Link, Ltd.
Fairey Aviation, Ltd.
M.L. Aviation Co., Ltd.
McMichael Radio, Ltd.

TRAINING EQUIPMENT, ARMAMENT

Brooklands Aviation, Ltd.
Fairey Aviation, Ltd.
Flight Refuelling, Ltd.
M.L. Aviation Co., Ltd.
Short Bros. and Harland, Ltd.

TRANSFERS, LETTERING, ETC.

Kaylee Transfers, Ltd.

TRANSFORMERS

British Thomson-Houston Co., Ltd., The
Cossor Radar and Electronics, Ltd.
de Havilland Propellers, Ltd.
English Electric Co., Ltd., The
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
General Electric Co., Ltd., The
Murphy Radio, Ltd. (Electronics Division)
Plessey Co., Ltd., The
Rotax, Ltd.
Salford Electrical Instruments, Ltd.
Savage, Ltd., W. Bryan
Sciaky Electric Welding Machines, Ltd.
Standard Telephones and Cables, Ltd.
Thorn Electrical Industries, Ltd.
Turner Electrical Instruments, Ltd., Ernest
Young, Ltd., A. W.

TRANSISTORS—see Semiconductors

TROLLEYS

Aerocontacts (Ground Equipment), Ltd.
Autocet (Production), Ltd.
Aviation Traders (Engineering), Ltd.
Avimo, Ltd.
Edghill and Co., Ltd., H. W.
Gordon and Co.
Henshall and Sons (Addlestone), Ltd., W.
Hercules Engineering Co., Ltd., The
M.L. Aviation Co., Ltd.
Portsmouth Aviation, Ltd.
Rollason Aerocessories, Ltd.

TRUCKS (FORK-LIFT, ETC)

Aerocontacts (Ground Equipment), Ltd.
Edghill and Co., Ltd., H. W.
Electro-Hydraulics, Ltd.
Mercury Truck and Tractor Co., Ltd.

TUBING, AIRCRAFT STAINLESS

Gordon and Co.

TUBING, AIRCRAFT STEEL

Accles and Pollock, Ltd.
Aircraft Materials, Ltd.
Gordon and Co.
Palmer Aero Products, Ltd.
Reynolds Tube Co., Ltd.
Talbot Stead Tube Co., Ltd.

TUBING, FLEXIBLE—see Hose, flexible

TUBING, SEAMLESS

Accles and Pollock, Ltd.
Avon India Rubber Co., Ltd., The
Booth and Co., Ltd., James
Chesterfield Tube Co., Ltd., The
Gordon and Co.
Imperial Chemical Industries, Ltd.
Palmer Aero Products, Ltd.
Reynolds Tube Co., Ltd.
Rollet and Co., Ltd., H.
Serck Radiators, Ltd.
Southern Forge, Ltd.
Talbot Stead Tube Co., Ltd.
Tubes, Ltd.

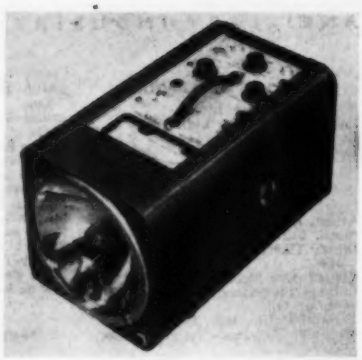
TUBING, OTHER THAN ABOVE

Accles and Pollock, Ltd.
Aircraft Materials, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
Gordon and Co.
Hellermann, Ltd.
Hordern-Richmond, Ltd.
Miles Structural Plastics, Ltd.
Northern Aluminium Co., Ltd.
Palmer Aero Products, Ltd.
Rollet and Co., Ltd., H.
Suntex Safety Glass Industries, Ltd.
Talbot Stead Tube Co., Ltd.
Telegraph Construction and Maintenance Co., Ltd., The
Wilson Alloys, Ltd.
Wilson and Sons (London), Ltd., W.

TUBULAR COMPONENTS

Accles and Pollock, Ltd.
Aviation Traders (Engineering), Ltd.
Gordon and Co.
Henshall and Sons (Addlestone), Ltd., W.
High-Pressure Components, Ltd.
Lancefield Aircraft Components, Ltd.
Palmer Aero Products, Ltd.

E.M.I. Type 6 stroboscope, with high-intensity xenon discharge tube. Flash rate, 60,000 per minute



Reynolds Tube Co., Ltd.
Talbot Stead Tube Co., Ltd.
Tubes, Ltd.
Wilmot Breeden, Ltd.
Woodside Die Sinking Co., Ltd.

TUNGUM ALLOYS

Tungum Co., Ltd., The

TYRES AND WHEELS, AIRCRAFT
(see also Brakes; and Wheels, Landing)

Aerocontacts (Aircraft Distributors), Ltd.
Dunlop Rubber Co., Ltd.
Firestone Tyre and Rubber Co., Ltd.
Goodyear Tyre and Rubber Co. (Great Britain), Ltd., The
Palmer Aero Products, Ltd.

UNDERCARRIAGES—see Landing gear

UNIFORM—see Clothing

UPHOLSTERY MATERIALS

Aerocontacts (Aircraft Distributors), Ltd.
British Replin, Ltd.
Connolly Bros. (Curriers), Ltd.
Fothergill and Harvey, Ltd.
Hairlok Co., Ltd., The
I.C.I. (Hyde), Ltd.
Jablo Propellers, Ltd.
Lancefield Aircraft Components, Ltd.
Latex Upholstery, Ltd.
Rumbold and Co., Ltd., L. A.
Williamson and Son, Ltd., Jas.

VALVES, ELECTRONIC

British Thomson-Houston Co., Ltd., The
Cathodeon, Ltd.
Cossor Instruments, Ltd.
Cossor Radar and Electronics, Ltd.
E.M.I. Electronics, Ltd.
English Electric Co., Ltd., The
Ericsson Telephones, Ltd.
Fairey Aviation, Ltd.
Ferranti, Ltd.
General Electric Co., Ltd., The
Marconi's Wireless Telegraph Co., Ltd.
Mullard, Ltd.
Palmer Aero Products, Ltd.
Standard Telephones and Cables, Ltd.

VALVES FOR AIR AND GASES

Appleby and Ireland, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
British Oxygen Gases, Ltd.
Davall and Sons, Ltd., S.
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
Godfrey and Partners, Ltd., Sir George
Graseby Instruments, Ltd.
Headland Engineering Developments, Ltd.
High-Pressure Components, Ltd.
Hymatic Engineering Co., Ltd., The
King Aircraft Corporation
Normalair, Ltd.
Palmer Aero Products, Ltd.
Rollason Aerocessories, Ltd.
Rotax, Ltd.
Saunders Valve Co., Ltd.
SPE Co., Ltd.
Teddington Aircraft Controls, Ltd.
Turner Manufacturing Co., Ltd.
Western Manufacturing (Reading), Ltd.
Williams and James (Engineers), Ltd.

VALVES FOR FLUIDS

Amal, Ltd.
Avery-Hardoll, Ltd.
Birkett, Billington and Newton, Ltd., T. M.
British Oxygen Gases, Ltd.
de Havilland Engine Co., Ltd., The
Dowty Equipment, Ltd.
Dunlop Rubber Co., Ltd.
Electro-Hydraulics, Ltd.
Fairey Aviation, Ltd.
Flight Refuelling, Ltd.
Gloster Aircraft Co., Ltd.
Gloster Technical Developments Division
HML (Engineering), Ltd.
High-Pressure Components, Ltd.
Hobson, Ltd., H. M.
Hymatic Engineering Co., Ltd., The
King Aircraft Corporation
Palmer Aero Products, Ltd.
Plessey Co., Ltd., The
Rollason Aerocessories, Ltd.
Rotol, Ltd
Rubery Owen and Co., Ltd.
Saunders Valve Co., Ltd.
SPE Co., Ltd.
Sperry Gyroscope Co., Ltd.
Teddington Aircraft Controls, Ltd.
Turner Manufacturing Co., Ltd.
Western Manufacturing (Reading), Ltd.
Weyburn Engineering Co., Ltd., The
Wilmot Breeden, Ltd.

VEHICLES (OTHER THAN CATEGORIES SPECIFICALLY NAMED)

Aviation Traders (Engineering), Ltd.
Douglas Equipment, Ltd.
Edghill and Co., Ltd., H. W.
M.L. Aviation Co., Ltd.
Mercury Truck and Tractor Co., Ltd.
Samlesbury Engineering, Ltd.

Britool torque wrench, with "touch, sight and sound" safety signal (Jenks Brothers, Ltd.)

ANCILLARY INDUSTRY 1959...

VIBRATION GENERATORS

E.M.I. Electronics, Ltd.
English Electric Co., Ltd., The
Goodmans Industries, Ltd.
Savage, Ltd., W. Bryan

VOLTAGE REGULATORS

Avimo, Ltd.
Bosch, Ltd.
British Thomson-Houston Co., Ltd., The
Eastern Aero Electrical Services, Ltd.
Ericsson Telephones, Ltd.
Ferranti, Ltd.
Ferranti Meters, Ltd., Denis
Marconi's Wireless Telegraph Co., Ltd.
Murphy Radio, Ltd. (Electronics Division)
Newton Bros. (Derby), Ltd.
Plessey Co., Ltd., The
Rotax, Ltd.
Sanders (Electronics), Ltd., W. H.
Savage, Ltd., W. Bryan
Stone and Co. (Deptford), Ltd., J.
Texas Instruments, Ltd.
Vernons Industries, Ltd.

WASHERS—see A.G.S. parts

WAVEGUIDES

Accles and Pollock, Ltd.
Amphenol (Great Britain), Ltd.
Bell Precision Engineering Co., Ltd.
British Insulated Callender's Cables, Ltd.
British Thomson-Houston Co., Ltd., The
Cossor Radar and Electronics, Ltd.
Davall and Sons, Ltd., S.
English Electric Aviation, Ltd.
Lancefield Aircraft Components, Ltd.
Marston Excelsior, Ltd.
Microcell, Ltd.
Rollet and Co., Ltd., H.
Sanders (Electronics), Ltd., W. H
Sankey-Telcon, Ltd.
Stone and Co. (Charlton), Ltd., J.
Wayne Kerr Laboratories, Ltd., The

WEIGHING EQUIPMENT, WORKSHOP

Gordon and Co.
Salter and Co., Ltd., Geo.

WEIGHING EQUIPMENT, AIRCRAFT

Gordon and Co.
Salter and Co., Ltd., Geo.

WEIGHING EQUIPMENT, PASSENGER, BAGGAGE, ETC.

E.M.I. Electronics, Ltd.

WEIGHING SERVICES, AIRCRAFT, ETC.

Scottish Aviation, Ltd.

WELDING EQUIPMENT, ELECTRICAL

Burnley Aircraft Products, Ltd.
Delaney Gallay, Ltd.
General Electric Co., Ltd., The
Hendrey Relays, Ltd.
Murex Welding Processes, Ltd.
Petbow, Ltd.
Philips Electrical, Ltd.
Quasi-Arc, Ltd.
Rubery Owen and Co., Ltd.
Sanders (Electronics), Ltd., W. H.
Sciaky Electric Welding Machines, Ltd.
Vernons Industries, Ltd.

WELDING EQUIPMENT, OTHER THAN ELECTRICAL

British Oxygen Gases, Ltd.
Electro-Hydraulics, Ltd.
Siebe, Gorman and Co., Ltd.

WHEELS, CASTOR, ETC., INDUSTRIAL

(see also specific items)
Autoset (Production), Ltd.
Flexello Castors and Wheels, Ltd.

WHEELS, LANDING

Dunlop Rubber Co., Ltd.
Goodyear Tyre and Rubber Co. (Great Britain), Ltd., The
Palmer Aero Products, Ltd.
Walter, Ltd., A. J.

WIND TUNNELS AND EQUIPMENT

Airscrew Co. and Jicwood, Ltd., The
Dobbie McInnes (Electronics), Ltd.
English Electric Aviation, Ltd.
General Electric Co., Ltd., The
Gordon and Co.
Harvey and Co. (London), Ltd., G.A.
Hercules Engineering Co., Ltd., The
Hordern-Richmond, Ltd.
Morfax, Ltd.
Short and Mason, Ltd.
Woodside Die Sinking Co., Ltd.

WIRE AND WIRE ROPES (see also Cables, control)

Aircraft Materials, Ltd.
Fox and Co., Ltd., Samuel
Heckford, Ltd., Arthur E.
Imperial Chemical Industries, Ltd.
Kaye, Ltd., E. and E.
Sankey-Telcon, Ltd.
Tungum Co., Ltd., The

WIRING AND WIRING ACCESSORIES, AIRCRAFT AND ENGINE

British Insulated Callender's Cables, Ltd.
Brown Bros. (Aircraft), Ltd.
C.W.C. Equipment, Ltd.
Fairey Aviation, Ltd.
General Electric Co., Ltd., The
Grundy and Partners, Ltd.
Kane, Ltd., Douglas
Page Engineering (Sunbury on Thames), Ltd.
Rotax, Ltd.

WOOD, PROCESSED

Bakelite, Ltd.
Export Packing Service, Ltd.
Hordern-Richmond, Ltd.
Jablo Propellers, Ltd.
Mallinson and Sons, Ltd., William
Saro Laminated Wood Products, Ltd.
Scotney, Ltd., Tom M.

ADDRESSES OF MANUFACTURERS AND SUPPLIERS

Abbey Engineering Co. (Coventry), Ltd., Old Church Road, Little Heath, Coventry, Warwicks. T: Coventry 89461. TA: Coventry 89461.

Abbey Panel and Sheet Metal Co., Ltd., Bayton Road, Exhall, Nr. Coventry, Warwicks. T: Bedworth 2071.

Abrasive Developments, Ltd., 17 High Street, Henley-in-Arden, Solihull, Warwicks. T: Henley-in-Arden 160. TA: Autoflow, Henley-in-Arden.

Accles and Pollock, Ltd., Oldbury, Birmingham. T: Broadwell 1500. TA: Accles, Oldbury, Telex.

Acratork Engineering Co., Ltd., Corys' Buildings, Cardiff. T: Cardiff 31141. TA: Acratork, Cardiff.

Adcola Products, Ltd., Gauden Road, Clapham, London, S.W.4. T: Macaulay 4272. TA: Soljoint, London.

Aero Controls, Ltd., Industrial Estate, Weedon Road, Northampton. T: Northampton 33131.

Aerocontacts (Aircraft Distributors), Ltd., Gatwick Airport, Horley, Surrey. T: Livingstone 8811 or Horley 5511. TA: Aerocon, Horley.

Aerocontacts (Ground Equipment), Ltd., Gatwick Airport, Horley, Surrey. T: Livingstone 8811 or Horley 5511. TA: Aerocon, Horley.

Aerocontacts (Sales), Ltd., Gatwick Airport, Horley, Surrey. T: Livingstone 8811 or Horley 5511. TA: Aerocon, Horley.

Aero-Enterprises (Boreham Wood), Ltd., 17 Drayton Road, Boreham Wood, Herts. T: Elstree 2688.

Aerogalley, Gatwick Airport, Horley, Surrey. T: Livingstone 8811 or Horley 5511. TA: Aerocon, Horley.

Aerolex, Ltd., Bridge Road, Camberley, Surrey. T: Camberley 1500. TA: Aerolex, Camberley.

Aeronautical Trades and Manufacturing Co., Ltd., 1 Wyndham Road, London, S.E.5. T: Rodney 7209. TA: Aertradman, London.

Agricultural Aviation Co., Ltd., Panshanger Aerodrome, Hertford, Herts. T: Essendon 424. TA: Agavco, Lettygreen.

Air Engine Services (U.S.-U.K.), Ltd., Blindley Heath, Lingfield, Surrey. T: Lingfield 2646. TA: Pratwit, Blindley Heath.

Aircraft and General Finance Corporation, Ltd., 3 Red Place, Green Street, London, W.1. T: Grosvenor 4360. TA: Emaviat, London.

Aircraft Furnishing, Ltd., 41 Lonsdale Road, London, W.11. T: Bayswater 6262.

Aircraft Materials, Ltd., Midland Road, London, N.W.1. T: Euston 6151. TA: Airworthy, Norwest.

Aircraft Unit Engineering Co., 18-19 Greenhill Parade, Great North Road, New Barnet, Herts. T: Barnet 6471.

Airline Air Spares, Ltd., Municipal Airport, Southend-on-Sea, Essex. T: Rochford 56881. TA: Telex 1943.

Airmed, Ltd., South Road, Harlow, Essex. T: Harlow 24331. TA: Airmed, Harlow.

Airport Restaurants, Ltd., Southend Municipal Airport, Southend-on-Sea, Essex. T: Rochford 56009.

Airscrew Co. and Jicwood, Ltd., The, Weybridge, Surrey. T: Weybridge 2242. TA: Airscrew, Weybridge.

Air Trainers Link, Ltd., Bicester Road, Aylesbury, Bucks. T: Aylesbury 4611. TA: Trainair.

Albright and Wilson (Mfg.), Ltd., 1 Knightsbridge Green, London, S.W.1. T: Kensington 3422. TA: Albriwil, Wesphone, London.

Aluminium Corporation, Ltd., 30 Charles II Street, London, S.W.1. T: Trafalgar 3104. TA: Fluxode, Piccy, London.

Amal, Ltd., Holdford Road, Witton, Birmingham, 6. T: Birchfields 4571. TA: Amalcarb, Phone, Birmingham.

Amar Tool and Gauge Co., Ltd., Grove Road, Chadwell Heath, Essex. T: Seven Kings 3471.

Amphenol (Great Britain), Ltd., Victoria Road, Burgess Hill, Sussex. T: Burgess Hill 85616. TA: Amphenol, Burgess Hill.

Amplivox, Ltd., Beresford Avenue, Wembley, Middx. T: Wembley 8991. TA: Amplivox, Wembley.

Anticoustic Co., The, 204 High Street, Guildford, Surrey. T: Guildford 66488.

Appleby and Ireland, Ltd., Basingstoke, Hants. T: Basingstoke 2510. TA: Apland, Basingstoke.

Appleby-Frodingham Steel Co. (branch of United Steel Companies, Ltd.), Scunthorpe, Lincs. T: Scunthorpe 3411. TA: Appford, Scunthorpe.

Armstrong Whitworth Aircraft, Ltd., Sir W. G., Baginton, Nr. Coventry, Warwicks. T: Toll Bar 2261. TA: Armcraft, Coventry.

Atlas Copco (Great Britain), Ltd., Maylands Avenue, Hemel Hempstead, Herts. T: Boxmoor 6040. TA: Atlascopco, Hemel Hempstead.

Atlas Plating Works, Ltd., 79 Avenue Road, Acton, London W.3. T: Acorn 1102

Attewell and Sons, Ltd., B., Reflection Works, Iver, Bucks. T: Iver 1102. TA: Reflection, Iver.

Auto Diesels, Ltd., Uxbridge, Middx. T: Uxbridge 8262. TA: Autodiesel, Uxbridge.

Automotive Products Co., Ltd., Tachbrook Road, Leamington Spa, Warwicks. T: Leamington Spa 2700. TA: Autoducts, Phone, Leamington Spa.

Autoset (Production), Ltd., Stour Street, Birmingham, 18. T: Edgbaston 1143. TA: Edgbaston 1143.

Avery-Hardoll, Ltd., Oakcroft Road, Chessington, Surrey. T: Elmbridge 5221. TA: Hardolpump, Phone, London.

Aviation and Engineering Projects, Ltd., Peregrine Works, Lampton Road, Hounslow, Middx. T: Hounslow 1136.

Aviation Developments, Ltd., Kingsbourne House, 229-231 High Holborn, London, W.C.1. T: Chancery 8601. TA: Avidev, Holb, London.

Aviation Traders (Engineering), Ltd., Municipal Airport, Southend-on-Sea, Essex. T: Rochford 56491.

Avica Equipment, Ltd., Mark Road, Hemel Hempstead, Herts. T: Boxmoor 4711. TA: Avica, Hemel Hempstead.

Avimo, Ltd., Herbert Street, Taunton, Somerset. T: Taunton 3634. TA: Avimo, Taunton.

Avo, Ltd., Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1. T: Victoria 3404. TA: Avocet, Sowest, London.

Avon India Rubber Co., Ltd., The (incorporating George Spencer Moulton and Co., Ltd.), Melksham, Wilts. T: Melksham 3101. TA: Rubber, Melksham.

B.B. Chemical Co., Ltd., Ulverscroft Road, Leicester. T: Leicester 20175. TA: Matchless, Leicester.

B.M.B. (Sales), Ltd., Boscobel, High Street, Crawley, Sussex. T: Crawley 1030. TA: Brimar, Crawley.

B.R.D. Co., Ltd., Aldridge, nr. Walsall, Staffs. T: Walsall 6551.

B.S.T. Aeronautical Co., Ltd., Blackbushe Airport, Camberley, Surrey. T: Camberley 1600.

Bakelite, Ltd., 12-18 Grosvenor Gardens, London, S.W.1. T: Sloane 0898. TA: Bakelite, Sowest, London.

Bardolph and Partners, Ltd., J. F., 1 Robert Street, Adelphi, London, W.C.2. T: Trafalgar 1927. TA: Loebwyn, Rand, London.

Baxters (Bolts, Screws and Rivets), Ltd., Sheepcote Street, Birmingham, 15. T: Midland 0105. TA: Makers, Birmingham.

Beaufort (Air-Sea) Equipment, Ltd. (division of P. Frankenstein and Sons), Beaufort Road, Birkenhead, Cheshire. T: Claughton 2667.

Bell Precision Engineering Co., Ltd., Victoria Works, High Street, Crawley, Sussex. T: Crawley 25757.

Belling and Lee, Ltd., Great Cambridge Road, Enfield, Middx. T: Enfield 3322. TA: Radiobell, Enfield.

Bellman Hangers, Ltd., Hobart House, Grosvenor Place, London, S.W.1. T: Sloane 5259. TA: Unitstruct, London.

Bell's Asbestos and Engineering, Ltd., Bestobell Works, Slough, Bucks. T: Slough 25151. TA: Bestobell, Slough.

Bennett (Hyde), Ltd., Boston Mills, Hyde, Cheshire. T: Hyde 1377. TA: Benneco, Phone, Hyde.

Birkett, Billington and Newton, Ltd., T. M., Birkett Street, Hanley, P.O. Box 201, Stoke-on-Trent, Staffs. T: Stoke-on-Trent 22184. TA: Birkett, Hanley.

Birmetals, Ltd., Woodgate Works, Quinton, Birmingham, 32. T: Birmingham Woodgate 2253. TA: Birmetals, Birmingham, 32.

Birmingham Aluminium Casting (1903) Co., Ltd., Dartmouth Road, Smethwick 40, Staffs. T: Smethwick 1431. TA: Birmal.

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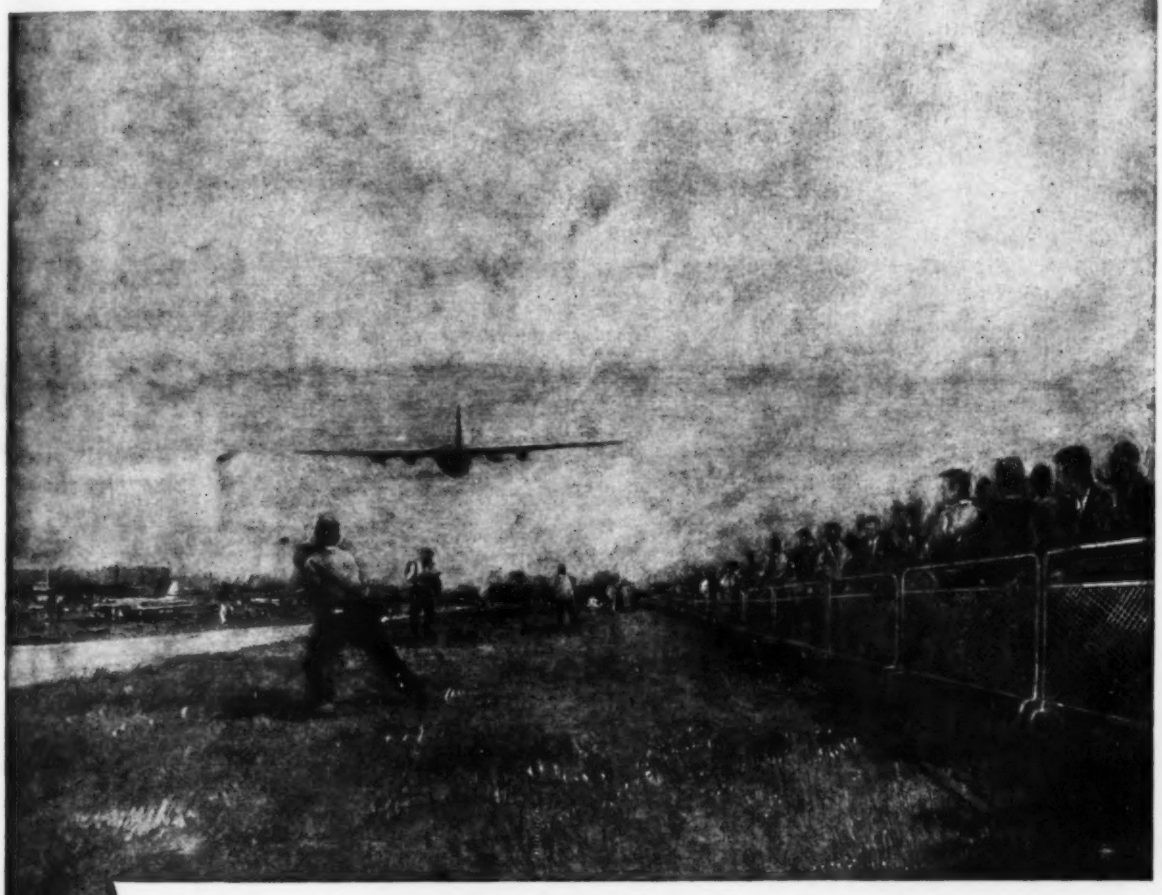

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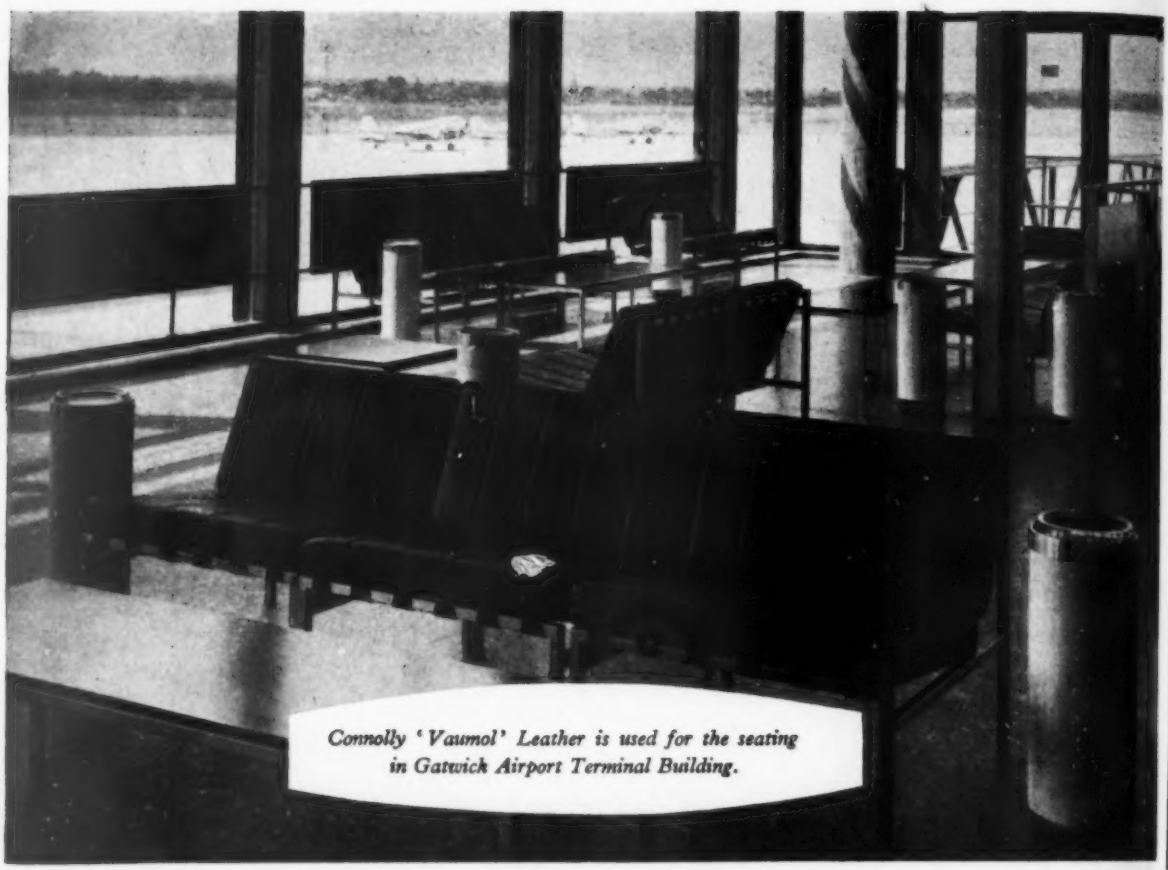

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Blackburn Engines, Ltd., Brough, Yorks. T: Brough 121. TA: Ocirruso, Broughyorks.
Bolton Gate Co., Ltd., Waterloo Street, Bolton, Lancs. T: Bolton 4240. TA: Gates, Bolton.
Boorn and Co., Ltd., Thomas, Venn Street, Clapham, London, S.W.4. T: Macaulay 1181. TA: Plumbago, Clapcom, London.
Booth and Co., Ltd., James, Argyle Street Works, Nechells, Birmingham, 7. T: East 1521. TA: Booth, Bham Telex.
Booth and Sons (Bolton), Ltd., John, Hulton Steelworks, Bolton, Lancs. T: Bolton 1195. TA: Irony, Bolton.
Bosch, Ltd., 20 Carlisle Road, The Hyde, Hendon, London, N.W.9. T: Colindale 0161. TA: Electright, London.
Boulton Paul Aircraft, Ltd., Wolverhampton, Staffs. T: Fordhouses 3191. TA: Aircraft, Wolverhampton.
Bradley, Ltd., G. and E., Electrical House, Neasden Lane, London, N.W.10. T: Gladstone 0012. TA: Bradelec, London, N.W.10.
Bramah and Co., Ltd., J. R., Devonshire Street, Sheffield. T: Sheffield 24228. TA: Bramah 24228 Sheffield.
Brand and Co., Ltd., R. A., Works Road, Letchworth, Herts. T: Letchworth 1990. TA: Texikoon, Letchworth.
Brent Chemical Products, Ltd., Commerce Road, Brentford, Middx. T: Isleworth 5444. TA: Ardrox, Brentford.
Bristol Aerojet, Ltd., Banwell, Weston-super-Mare, Somerset. T: Banwell 250. TA: Brisjet.
Bristol Aircraft, Ltd., Filton House, Bristol. T: Filton 3831. TA: Aviation, Bristol.

Davall Type 266 propeller and engine de-icing cyclic timer

British Aluminium Co., Ltd., The, Norfolk House, St. James's Square, London, S.W.1. T: Whitehall 7868. TA: Britalumin, London, Telex.
British Aviation Insurance Co., Ltd., The, 3-4 Lime Street, London, E.C.3. T: Mansion House 0444. TA: Aviacoy, Stock, London.
British Industrial Plastics, Ltd., Tat Bank House, Oldbury, Birmingham. T: Broadwell 2061. TA: Plastobrit, Oldbury.
British Insulated Callender's Cables, Ltd., 21 Bloomsbury Street, London, W.C.1. T: Museum 1600. TA: Bicalbest, London, Telex.
British Manufacture and Research Co., Ltd., Springfield Road, Grantham, Lincs. T: Grantham 700. TA: Marco, Telex, Grantham.
British MonoRail, Ltd., Wakefield Road, Brighouse, Yorks. T: Brighouse 2244. TA: MonoRail, Brighouse.
British Oxygen Gases, Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1. T: Whitehall 9777. TA: Brioxygen, Piccy, London.
British Paints, Ltd., Crewe House, Curzon Street, London, W.1. T: Grosvenor 6401.
British Refrasil Co., Ltd., The, Stillington, Nr. Stockton-on-Tees, Co. Durham. T: Stillington 351. TA: Refrasil, Stillington, Co. Durham.
British Replin, Ltd., 2 South Audley Street, London, W.1. T: Grosvenor 6692. TA: Replin, London.
British Thomson-Houston Co., Ltd., The, Lower Ford Street, Coventry, Warwicks. T: Coventry 64181. TA: Asteroidal, Coventry.
British Timken, Ltd., Duston, Northampton. T: Northampton 4921 and 3452. TA: Britimken, Northampton, Telex.
Brooklands Aviation, Ltd., Beech Hollow, Vale Road, Oatlands Park, Weybridge, Surrey. T: Weybridge 3821. TA: Aviation, Byfleet.

Brown Bayley Steels, Ltd., Riverdale Road, Fulwood, Sheffield, 10. T: Sheffield 33931. TA: Bayley, Sheffield, 10.
Brown Bros. (Aircraft), Ltd., Bedford Road, Northampton. T: Northampton 4940. TA: Imbrowned, Northampton.
Brown, Ltd., N. C., Eagle Steel Works, Heywood, Lancs. T: Heywood 69018. TA: Brownsteel, Heywood.
Brown, Ltd., S. G., Shakespeare Street, Watford, Herts. T: Watford 27241. TA: Sidbrownix, Watford.
Brown Construction Equipment, Ltd., David, Hanworth Park, Feltham, Middx. T: Feltham 3641. TA: Indtrac, Feltham.
Brush Crystal Co., Ltd., The, Shore Road, Hythe, Southampton. T: Hythe 3031. TA: Brudev, Hythe, Southampton.
Bryans Aeroquipment, Ltd., 1 and 15 Willow Lane, Mitcham Junction, Surrey. T: Mitcham 5134. TA: Bryquip, Souphone, London.
Burndept, Ltd., West Street, Erith, Kent. T: Erith 3080. TA: Burndept, Erith.
Burnley Aircraft Products, Ltd., Fulledge Works, Holme Street, Burnley, Lancs. T: Burnley 3121 and 3203. TA: Aircraft, Burnley.

C. and N. (Electrical), Ltd., The Green, Gosport, Hants. T: Gosport 80221. TA: Nicholsons, Gosport.
CJC Developments (Portsmouth), Ltd., Fitzherbert Road, Farlington, Portsmouth, Hants. T: Cosham 76437. TA: Tangible, Portsmouth.
C.W.C. Equipment, Ltd., Kings Grove, Maidenhead, Berks. T: Maidenhead 2275. TA: Duraquip, Maidenhead.
Carlisle and Co., Ltd., C. G., Iona Steelworks, Penistone Road, Sheffield, 6. T: Sheffield 348791. TA: Nichrome.
Cathodeon Crystals, Ltd., Linton, Cambridge. T: Linton 501. TA: Quartz, Cambridge.
Cathodeon, Ltd., Church Street, Cambridge. T: Cambridge 56481. TA: Cathodeon, Cambridge.
Ceag, Ltd., Queens Road, Barnsley, Yorks. T: Barnsley 2203. TA: Ceag, Barnsley.
Celion, Ltd., Richmond Road, Kingston-on-Thames, Surrey. T: Kingston 1234. TA: Ajawb, Phone, Kingston.
Cementation (Muffelite), Ltd., 20 Albert Embankment, London, S.E.11. T: Reliance 6556.
Chelton (Electrostatics), Ltd., Marlow, Bucks. T: Marlow 1063.
Chesterfield Tube Co., Ltd., The, Chesterfield, Derbyshire. T: Chesterfield 2201. TA: Tubes, Chesterfield.
Chinn and Co., Ltd., J. S., Coventry Road, Exhall, Coventry. T: Bedworth 2077. TA: Bedworth 2077.
Chloride Batteries, Ltd., Exide Works, Clifton Junction, Swinton, Nr. Manchester. T: Swinton 2011. TA: Chlorexide, Manchester.
CIBA (A.R.L.), Ltd., Duxford, Cambridge. T: Sawston 2121. TA: Aerodux, Cambridge.
Clifford Products, Ltd., Imperial Works, Friar Street, Wednesday, Staffs. T: Wednesbury 1771. TA: Cliffpro, Wednesbury.
Coin Insulation, Ltd., Coin Works, St. Johns Road, Woking, Surrey. T: Woking 4789. TA: Coin, Woking.
Cole, Ltd., E. K., Ekco Works, Southend-on-Sea, Essex. T: Southend-on-Sea 49491. TA: Ekco, Southend-on-Sea.

Coley and Son (Hounslow), Ltd., R. J., Mill Farm Works, Hanworth Road, Hounslow, Middx. T: Hounslow 2266. TA: Metalful, Hounslow.
Connolly Bros. (Curriers), Ltd., 39-43 Chalton Street, London, N.W.1. T: Euston 1661. TA: Cowhide, Phone, London.
Coopers Mechanical Joints, Ltd., Liverpool Road, Slough, Bucks. T: Slough 24511. TA: Endure Slough, Telex.
Corner and Co., Ltd., G., Johnson Brook Road, Hyde, Cheshire. T: Hyde 3493.
Cornercroft, Ltd., Ace Works, Coventry, Warwicks. T: Coventry 40561. TA: Discs, Coventry.
Cossor Instruments, Ltd., Cossor House, Highbury Grove, London, N.5. T: Canonbury 1234. TA: Cossor, Norphone, London.
Cossor Radar and Electronics, Ltd., The Pinnacles, Elizabeth Way, Harlow, Essex. T: Harlow 26862. TA: Cossor, Harlow.
Costain, Ltd., Richard, 111 Westminster Bridge Road, London, S.E.1. T: Waterloo 4977. TA: Cosdown, London, S.E.1.
Coventry Climax Engines, Ltd., Widdrington Road Works, Coventry, Warwicks. T: Coventry 62607. TA: Climax, Coventry.
Cramic Aircraft Components, Ltd., Bridge Road, Southall, Middx. T: Southall 3411. TA: Cramic Phone, Southall.
Cross Manufacturing Co. (1938), Ltd., 33 Midford Road, Combe Down, Bath, Somerset. T: Combe Down 2355. TA: Circle, Bath.
Crossley (Packings), Ltd., Henry, Hill Mill, P.O. Box 7, Astley Bridge, Bolton, Lancs. T: Higher Bolton 41351. TA: Crosslite, Bolton.
Cullum and Co., Ltd., Horace W., The Acoustic Centre, 58 Highgate West Hill, London, N.6. T: Fitzroy 1221. TA: Kulmco, London, N.6.
Cullum Detuners, Ltd., The Acoustic Centre, 58 Highgate West Hill, London, N.6. T: Fitzroy 1221. TA: Kulmco, London, N.6.
Curd Components, Ltd., 9 Brownfields, Welwyn Garden City, Herts. T: Welwyn Garden 5471. TA: Curdcsy, W.G.C.
Curran, Ltd., John, P.O. Box 72, Cardiff. T: Cardiff 20641. TA: Narruc, Cardiff.

Davall and Sons, Ltd., S., 8 Wadsworth Road, Greenford, Middx. T: Alperton 1011.
Dawe Instruments, Ltd., 99-101 Uxbridge Road, Ealing, London, W.5. T: Ealing 6215. TA: Dawinst, Ealux, London.
Decca Navigator Co., Ltd., The, Decca House, 9 Albert Embankment, London, S.E.11. T: Reliance 8111. TA: Decnav, London.
Decca Radar, Ltd., Decca House, 9 Albert Embankment, London, S.E.11. T: Reliance 8111. TA: Decradar, London.
de Havilland Aircraft Co., Ltd., The, Hatfield, Herts. T: Hatfield 2345. TA: Haviland, Telex, Hatfield.
de Havilland Engine Co., Ltd., The, Leavesden, Herts. T: Garston 4000. TA: Gipsy, Watford.
de Havilland Propellers, Ltd., Manor Road, Hatfield, Herts. T: Hatfield 2300. TA: Props, Telex, Hatfield.
Delaney Gallay, Ltd., Vulcan Works, Edgware Road, Cricklewood, London, N.W.2. T: Gladstone 2201. TA: Delanair.
Denney, O'Hara, Ltd., Peacocks Chambers, 23 Park Row, Leeds, 1. T: Leeds 33784.
Derby Aviation, Ltd., 78 Buckingham Gate, London, S.W.1 and Derby Airport, Derby. T: Abbey 2345 and Etwall 323.
Desoutter Bros., Ltd., The Hyde, Hendon, London, N.W.9. T: Colindale 6346. TA: Despruco, Hyde, London.

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Distington Engineering Co., Ltd. (subsidiary of United Steel Companies, Ltd.), P.O. Box 8, Chapel Bank Works, Workington, Cumberland. T: Workington 661. TA: Chapbank, Workington.
Docker Bros., Rotton Park Street, Ladywood, Birmingham, 16. T: Edgbaston 4111. TA: Edgbaston 4111.
Dobbie McInnes (Electronics), Ltd., 55 Kelvin Avenue, Hillington, Glasgow, S.W.2. T: Halfway 3364. TA: Electronic, Glasgow.
Douglas Equipment, Ltd., Kingsditch Lane, Tewkesbury Road, Cheltenham, Glos. T: Cheltenham 56361. TA: Douglas, Cheltenham.
Dowty Equipment, Ltd., Arle Court, Cheltenham, Glos. T: Cheltenham 53471. TA: Dowtys, Cheltenham, Telex.
Dowty Fuel Systems, Ltd., Arle Court, Cheltenham, Glos. T: Cheltenham 53471. TA: Dowtys, Cheltenham, Telex.

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Dragonair, Ltd., Fitzherbert Road, Farlington, Portsmouth, Hants. T: Cosham 76451. TA: Evarges, Portsmouth.
Dundas, Ltd., R. K., Dundas House, 59 St. Jame's, London, S.W.1. T: Hyde Park 3717. TA: Dunduk, London.
Dunlop Rubber Co., Ltd., Aviation Division, Holbrook Lane, Foleshill, Coventry, Warwicks. T: Coventry 88733. TA: Sound, Coventry.
Dzus Fastener Europe, Ltd., Farnham Factory Estate, Guildford Road, Farnham, Surrey. T: Farnham 4422. TA: Adzusfast, Farnham.

E.M.I. Electronics, Ltd., Hayes, Middx. T: Southall 2468. TA: Emidata, London.
E.M.O. Instrumentation, Ltd., Western Road, Bracknell, Berks. T: Bracknell 675. TA: Precemo, Bracknell.
E.N.V. Engineering Co., Ltd., Hythe Road, Willesden, London, N.W.10. T: Ladbroke 3622. TA: Envied, Telex, London.
E.P.S. (Research and Development), Ltd., Staplehurst Road, Sittingbourne, Kent. T: Sittingbourne 1313. TA: Expac, Sittingbourne.
Eagle Aircraft Services, Ltd., Blackbushe Airport, Camberley, Surrey. T: Yateley 2371. TA: Eagle, Camberley.
Eastern Aero Electrical Services, Ltd., Priory Street, Colchester, Essex. T: Colchester 6173. TA: Eastaulec.
Edghill and Co., Ltd., H. W., Odiham Road, Hook, Nr. Basingstoke, Hants. T: Hook 40.
Ekco Electronics, Ltd., Ekco Works, Southend-on-Sea, Essex. T: Southend-on-Sea 49491. TA: Ekco, Southend-on-Sea.
Electro-Hydraulics, Ltd., Liverpool Road, Warrington, Lancs. T: Warrington 35241. TA: Hydraulics, Warrington.
Electro Mechanisms, Ltd., 220 Bedford Avenue, Slough, Bucks. T: Slough 22228.
Elliot Equipment, Ltd., c/o Cory Bros. and Co., Ltd., 8 Great Tower Street, London, E.C.3. T: Mansion House 3477. TA: Cory, Easphone, London.
Elliott Bros. (London), Ltd., Airport Works, Maidstone Road, Nr. Rochester, Kent. T: Chatham 44400. TA: Autoswift.
English Electric Aviation, Ltd., Marconi House, Strand, London, W.C.2. T: Covent Garden 1234. TA: Enelectico, Estrand, London.
English Electric Co., Ltd., The, Aircraft Equipment Division, Phoenix Works, Bradford, Yorks. T: Bradford 65221. TA: Enelectico, Bradford.
English Steel Castings Corporation, Ltd., River Don Works, Sheffield. T: Sheffield 41071. TA: Steelcorpo, Sheffield.
English Steel Forge and Engineering Corporation, Ltd., River Don Works, Sheffield. T: Sheffield 41071. TA: Steelcorpo, Sheffield.
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Ericsson Telephones, Ltd., Telephone Works, Beeston, Nottingham. T: Beeston 25-4831. TA: Ericsson, Beeston, Nottingham.
Erith Engineering (Leicester), Ltd., Kenilworth Drive, Oadby, Leicester. T: Oadby 2471.
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Esso Petroleum Co., Ltd., 50 Stratton Street, London, W.1. T: Hyde Park 7030. TA: Aircaso, London.
Exactor, Ltd., Exactor Works, Church Way, Edgware, Middx. T: Edgware 0071. TA: Exactor, Phone, Edgware.
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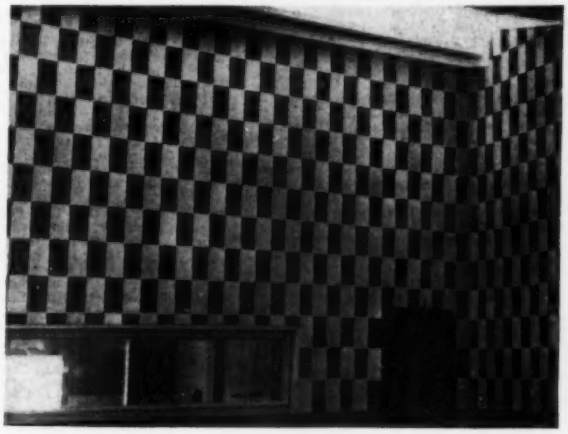

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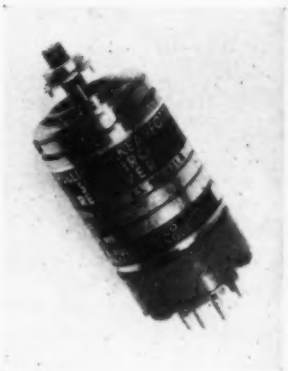
Preformations, Ltd., Cheney Manor, Swindon, Wilts. T: Swindon 6251.
Pullin and Co., Ltd., R. B., Phenix Works, Great West Road, Brentford, Middx. T: Isleworth 1212. TA: Pullinco, Wesphone, London.
Pulsometer Engineering Co., Ltd., Nine Elms Iron Works, Oxford Road, Reading, Berks. T: Reading 67182. TA: Pulsometer, Reading.
Purefoy Unit Tooling, Ltd., J. B., Upper Tilt Works, Cobham, Surrey. T: Cobham 3013. TA: Purefoy, Cobham, Leatherhead.
Putnam and Co., Ltd., 42 Great Russell Street, London, W.C.1. T: Museum 0835. TA: Putnam, Westcent.
Pye Telecommunications, Ltd., Ditton Works, Newmarket Road, Cambridge. T: Teversham 3131. TA: Pyetelecom, Cambridge.
Pyrene Co., Ltd., The, 9 Grosvenor Gardens, London, S.W.1. T: Victoria 3401. TA: Pyrenextin, Sowest, London.

Quality Bearings, Ltd., 218-221 Bedford Avenue, Slough, Bucks T: Slough 22228. TA: Immac, Slough.
Quasi-Arc, Ltd., Bilston, Staffs. T: Bilston 41905. TA: Quazarc, Bilston.

R.F.D. Co., Ltd., Godalming, Surrey. T: Godalming 1441. TA: Airships, Godalming.
R.M.R. Engineering, Old Silk Mill, Brook Street, Tring, Herts. T: Tring 3338.
Racal Engineering, Ltd., Western Road, Bracknell, Berks. T: Bracknell 941. TA: Racal, Bracknell.
Ransome and Marles Bearing Co., Ltd., Newark on Trent, Notts. T: Newark 456. TA: Bearings, Newark, Telex.

Airfield mobile workshop by Morfax, Ltd.

Rapp, Ltd., Leo, Wimborne Avenue, Norwood Green, Southall, Middx. T: Southall 2322. TA: Metalrapps, Southall.
Ratcliffe (Rochdale), Ltd., F. S., Crawford Spring Works, Norman Road, Rochdale, Lancs. T: Rochdale 4692. TA: Recoil, Rochdale.
Rawlplug Co., Ltd., The, Cromwell Road, London, S.W.7. T: Fremantle 8111. TA: Rawlplug, Southkens.
Redifon, Ltd., Broomhill Road, Wandsworth, London, S.W.18. T: Vandyke 7281. TA: Redifon, London.
Redwing, Ltd., 340 Bensham Lane, Thornton Heath, Surrey. T: Thornton Heath 3663. TA: Redwing, Croydon.
Regent Oil Co., Ltd., 117 Park Street, London, W.1. T: Mayfair 8474. TA: Biregent, Audley, London.
Reid and Sigrist, Ltd., Braunstone Works, Airport Lane, Braunstone, Leicester. T: Leicester 858101. TA: Reidsig, Leicester.
Reliance Chords and Cables, Ltd., Staffa Road, Leyton, London, E.10. T: Leytonstone 3620. TA: Cablekords, London.

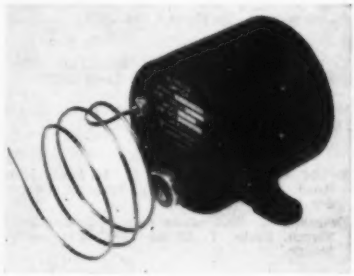


Pullin - Kearfoot synchro - resolver (R. B. Pullin and Co., Ltd.)

Reilumit (London), Ltd., Chandos House, Palmer Street, London, S.W.1. T: Abbey 3304. TA: Reilumit, London.
Renold Chains, Ltd., Renold House, Wythenshawe, Manchester. T: Gatley 5221. TA: Driving, Telex, Manchester.
Research and Control Instruments, Ltd., Instrumeat House, 207 Kings Cross Road, London, W.C.1. T: Terminus 8444. TA: Racil, Kincross.
Reynolds T.I. Aluminium, Ltd., 10 Buckingham Place, London, S.W.1. T: Victoria 0902. TA: Timinium, London.
Reynolds Tube Co., Ltd., Hay Hall Works, Tyseley, Birmingham, 11. T: Acocks Green 3333. TA: Butted, Birmingham.
Riley, Ltd., Robert, Milkstone Spring Works, Mere Lane, Rochdale, Lancs. T: Rochdale 2237. TA: Rilospring, Telex, Rochdale.
Rist's Wires and Cables, Ltd., Lower Milehouse Lane, Newcastle, Staffs. T: Newcastle 51221. TA: Rists, Newcastle.
Robinson and Co. (Gillingham), Ltd., L., London Chambers, Gillingham, Kent. T: Gillingham 5282.
Rollason Aerocessories, Ltd., Croydon Airport, Croydon, Surrey. T: Croydon 7238. TA: Rollacess, Croydon.
Rollason Aircraft and Engines, Ltd., Croydon Airport, Croydon, Surrey. T: Croydon 5151. TA: Rollair, Croydon.
Rollet and Co., Ltd., H., 6 Chesham Place, London, S.W.1. T: Sloane 3463. TA: Nonferous, Westphone, London.
Rose Bros. (Gainsborough), Ltd., Albion Works, Gainsborough, Lincs. T: Gainsborough 2231. TA: Rose, Gainsborough, Telex.
Rotax, Ltd., Willesden Junction, London, N.W.10. T: Elgar 7777. TA: Rodynalite, London.
Rotol, Ltd., Cheltenham Road, Gloucester. T: Gloucester 24431. TA: Rotol, Gloucester.
Rover Gas Turbines, Ltd., Meteor Works, Lode Lane, Solihull, Warwicks. T: Sheldon 4242. TA: Rovcrturbo, Solihull.
Royce Electric Furnaces, Ltd., Sir Richards Bridge, Walton on Thames, Surrey. T: Walton 2577.
Rozalex, Ltd., 10 Norfolk Street, Manchester, 2. T: Blackfriars 1122. TA: Blackfriars 1122.
Rubery Owen and Co., Ltd., P.O. Box 10, Darlaston, Wednesbury, Staffs. T: James Bridge 3131. TA: Ruberowen, Telex, Darlaston.
Rumbold and Co., Ltd., L. A., Kingsgate Place, Kilburn, London, N.W.6. T: Maida Vale 7366. TA: Rumboldair, Klib, London.
Ryland, Ltd., Llewellyn, Bainall Heath Works, Haden Street, Birmingham, 12. T: Caltharpe 2284. TA: Llewellyn, Ryland, Birmingham.

ANCILLARY INDUSTRY 1959..

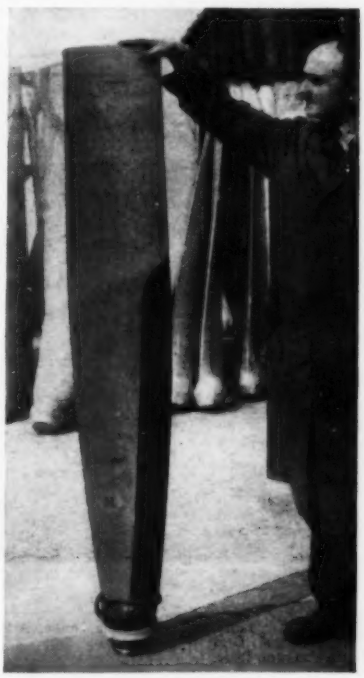
St. Helens Cable and Rubber Co., Ltd., St. Helens Works, Slough, Bucks. T: Slough 20333. TA: St. Helens, Slough.
Salter and Co., Ltd., Geo., High Street, West Bromwich, Staffs. T: West Bromwich 1855. TA: Telex 33/114.
Salford Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, 3, Lancs. T: Blackfriars 6688. TA: Sparkless, Manchester.
Samlesbury Engineering, Ltd., Samlesbury Airfield, Nr. Blackburn, Lancs. T: Blackburn 44668. TA: Croflite, Blackburn.
Sanders (Electronics), Ltd., W. H., Gunnell Wood Road, Stevenage, Herts. T: Stevenage 981. TA: Sandelect, Stevenage.
Sangamo Weston, Ltd., Enfield, Middx. T: Enfield 3434. TA: Sanwest, Enfield.
Sankey and Sons, Ltd., Joseph, Albert Street Works, Bilston, Staffs T: Bilston 41161. TA: Sankey, Bilston.
Sankey-Telcon, Ltd., Crawley, Sussex. T: Crawley 1560. TA: Telcon, Crawley.
Saro Laminated Wood Products, Ltd., Folly Works, Whippingham, East Cowes, Isle of Wight. T: Cowes 704. TA: Saroy, Cowes, Telex.
Saunders-Roe, Ltd., Osborne, East Cowes, Isle of Wight. T: Cowes 2211. TA: Saroplane, East Cowes.
Saunders-Roe (Anglesey), Ltd., Beaumaris, Anglesey, North Wales. T: Beaumaris 130. TA: Searoads, Beaumaris.
Saunders Valve Co., Ltd., Blackfriars Street, Hereford. T: Hereford 3125. TA: Saunval, Hereford.
Savage, Ltd., W. Bryan, 17 Stratton Street, Mayfair, London, W.1. T: Grosvenor 1926. TA: Decibel, London.
Schermuly Pistol Rocket Apparatus, Ltd., 51 Coleman Street, London, E.C.2. T: Monarch 9307. TA: Spra, Stock, London.
Sciaky Electric Welding Machines, Ltd., Falmouth Road, Trading Estate, Slough, Bucks. T: Slough 25551. TA: Sciakyweld, Slough.
Scotney, Ltd., Tom M., London Road, St. Ives, Hunts. T: St. Ives 2421. TA: Scotney, St. Ives, Huntingdon.



Teddington Aircraft Controls altitude switch, Type PAD/A/O

Scottish Aviation, Ltd., Prestwick Airport, Ayrshire, Scotland. T: Prestwick 79888. TA: Aeronautics, Prestwick.
Secker and Warburg, Martin, 7 John Street, Bloomsbury, London, W.C.1. T: Holborn 4855. TA: Psophidian.
Semiconductors, Ltd., Cheney Manor, Swindon, Wilts. T: Swindon 6421. TA: Semicon, Swindon.
Serck Radiators, Ltd., Warwick Road, Birmingham, 11. T: Victoria 4353. TA: Serckrad, Birmingham.
SFIM (Great Britain), Ltd., 220 Bedfod Avenue, Slough, Bucks. T: Slough 22228. TA: SFIM, Slough.
Shackleton, Ltd., W. S., 175 Piccadilly, London, W.1. T: Hyde Park 2448. TA: Shackhud.
Sheffield Smelting Co., Ltd., The, Royds Mill Street, Sheffield, 4. T: Sheffield 26511. TA: Smelters, Sheffield, 4.
Shell-Mex and BP, Ltd., Shell-Mex House, Strand, London, W.C.2. T: Temple Bar 1234. TA: Shelbeepee, Telex, London.
Short and Mason, Ltd., Aneroid Works, 280 Wood Street, Walthamstow, London, E.17. T: Coppermill 2203. TA: Aneroid, Easphone, London.
Short Bros. and Harland, Ltd., East India House, 208a Regent Street, London, W.1. T: Regent 8716. TA: Predivis, London.
Siebe, Gorman and Co., Ltd., Neptune Works, Davis Road, Chessington, Surrey. T: Elmbridge 5900. TA: Siebe, Chessington.
Siemens Edison Swan, Ltd., 155 Charing Cross Road, London, W.C.2. T: Gerrard 8660. TA: Sieswan, Westcent, London.
Simmonds Aerocessories, Ltd., Treforst, Pontypridd, Glamorgan. T: Treforest 2211. TA: Aerocessim, Pontypridd.
Simon Engineering (Midlands), Ltd., Queens Cross, Dudley, Worcs. T: Dudley 54661. TA: Paragon, Dudley.
Skefko Ball Bearing Co., Ltd., The, Leagrave Road, Luton, Beds. T: Luton 5700. TA: Skefko, Telex, Luton.
Skyhi, Ltd., Pulsometer House, 20-26 Lamb's Conduit Street, London, W.C.1. T: Holborn 1402. TA: Skyhijack, Norphone, London.
Skyways, Ltd., Stansted Airport, Stansted, Essex. T: Bishops Stortford 1641. TA: Skyways, Ops, Stansted.
Smart and Brown (Machine Tools), Ltd., 25 Manchester Square, London, W.1. T: Welbeck 2971. TA: Smartool, Wesdo, London.
Smith Sections, 338 Swindon Road, Cheltenham, Glos. T: Cheltenham 56016.
Smiths Aviation Division, Cricklewood Works, London, N.W.2. T: Gladstone 3333. TA: Airspeed, Telex, London.
Smith's Stamping Works (Coventry), Ltd., Ribble Road Works, Humber Avenue, Coventry, Warwicks. T: Coventry 3151. TA: Force, Coventry.
Solartron Electronic Group, Ltd., The, Thames Ditton, Surrey. T: Emberbrook 5522. TA: Solartron, Thames Ditton.
Solus-Schall, Ltd., 15-18 Clipstone Street, Great Portland Street, London, W.1. T: Museum 5080. TA: Schall, Wesphone, London.
Somers, Ltd., J. N, 142-8 Edgware Road, London, W.2. T: Paddington 7661.
Southern Forge, Ltd., Meadfield Road, Langley, Bucks. T: Langley 301. TA: Forgings, Slough.
Southern Instruments, Ltd., Frimley Road, Camberley, Surrey. T: Camberley 3401. TA: Minrak, Camberley.
Spa Guilds, Ltd., Precision Works, St. James Square, Cheltenham, Glos. T: Cheltenham 53312.
Sparklets, Ltd., Queen Street, Tottenham, London, N.17. T: Tottenham 0881. TA: Sparklets, London.
SPE Co., Ltd., Edinburgh Avenue, Trading Estate, Slough, Bucks. T: Slough 23277. TA: Priming, Slough.
Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middx. T: Isleworth 1241. TA: Sperigyco, London. Telex.
Spring Washers, Ltd., Wobaston Road, Fordhouses, Wolverhampton, Warwicks. T: Fordhouses 2176. TA: Soaring, Wolverhampton.
Spurling Motor Bodies, Ltd., Edgware Road, The Hyde, Hendon, London, N.W.9. T: Colindale 7171. TA: Spurmobo, Hyde, London.
Standard Telephones and Cables, Ltd., Connaught House, 63 Aldwych, London, W.C.2. T: Holborn 8765. TA: Relay, London.
Steatite and Porcelain Products, Ltd., Stourport-on-Severn, Worcs. T: Stourport-on-Severn 2271. TA: Steatain, Stourport-on-Severn.
Steel Equipment Co., Ltd., Greets Green, West Bromwich, Staffs. T: Tipton 2521. TA: Equipit, West Bromwich.
Steel, Peech and Tozer (branch of United Steel Companies, Ltd.), P.O. Box 50, The Ickles, Rotherham, Yorks. T: Rotherham 2181. TA: Phoenix, Rotherham, Telex.
Steel Stampings, Ltd., Cookley, Nr. Kidderminster, Worcs. T: Wolverley 266. TA: Stampings, Cookley.
Sterling Metals, Ltd., Gipsy Lane, Nuneaton, Warwicks. T: Nuneaton 4221. TA: Stermet, Phone, Nuneaton.
Stewart Aeronautical Supply Co., Ltd., Adastral House, Nutfield, Redhill, Surrey. T: Redhill 5050. TA: Sasco, Redhill.
Stone and Co. (Charlton), Ltd., J, Woolwich Road, Charlton, London, S.E.7. T: Greenwich 3277. TA: Tostones, Wol, London.
Stone and Co. (Deptford), Ltd., J, Arklon Road, London, S.E.14. T: Tideway 1202. TA: Tostones, London, Telex.
Stream-Line Filters, Ltd., Henley Pask, Guildford, Surrey. T: Guildford 68755. TA: Edgefilt, Guildford.
Stuart, C. G. B., Fairlight Hall, Hastings.
Stuart (London), Ltd., Robert, 10 Aschan Street, Kentish Town, London, N.W.5. T: Gulliver 6141.
Suntex Safety Glass Industries, Ltd., Thorney Lane, Iver, Bucks. T: Iver 11. TA: Suntex, Iver.
Super Oil Seals and Gaskets, Ltd., Birmingham Factory Centre, Kings Norton, Birmingham 30. T: Kings Norton 2041. TA: Oilseal, Birmingham.
Surridges Patents, Ltd., New Works, Croydon Road, Elmers End, Beckenham, Kent. T: Beckenham 0168. TA: Surridge, Beckenham.
Sutton (Consultants), Ltd., R. W, 7 Lansdown Place, Cheltenham, Glos. T: Cheltenham 5811. TA: Cheltenham 5811.

Talbot Stead Tube Co., Ltd., Green Lane, Walsall, Staffs. T: Walsall 4186. TA: Talbot, Phone, Walsall.
Taylor, Taylor and Hobson (division of Rank Precision Industries, Ltd.), Stoughton Street, Leicester. T: Leicester 20134. TA: Lenses, Leicester, Telex.
Tecalemit, Ltd., Plymouth, Devon. T: Plymouth 62844. TA: Tecalemit, Plymouth.
Technical Ceramics, Ltd., Wood Burcote Way, Towcester, Northants. T: Towcester 337.
Technical Platings, Ltd., Craig's Works, Luther Road, Teddington, Middx. T: Molesey 240 and 4381.
Technical Publications and Supplies, Ltd., Peregrine Works, Lampton Road, Hounslow, Middx. T: Hounslow 1136.
Teknograph Electronic Products, Ltd., Eros House, 29-31 Regent Street, London, S.W.1. T: Regent 5273. TA: Teknograph, Piccy, London.
Teddington Aircraft Controls, Ltd., Cefn Coed, Merthyr Tydfil, South Wales. T: Merthyr Tydfil 3261. TA: Precision, Merthyr Tydfil.
Teleflex Products, Ltd., Basildon, Essex. T: Basildon 22861. TA: Teleflex, Phone, Basildon.
Telegraph Construction and Maintenance Co., Ltd., The, Mercury House, Theobald's Road, London, W.C.1. T: Holborn 8711. TA: Telcon, London.
Tempered Spring Co., Ltd., The, Warren Street, Sheffield 4. T: Sheffield 21333. TA: Tempered, Sheffield.



This propeller blade (for a Gulfstream) is the 100,000th metal blade made by Rotol, Ltd., since they started manufacturing them in 1938

Templewood Hawksley, Ltd., 2 Buckingham Avenue, Slough, Bucks. T: Slough 23212. TA: Temphawk, Slough.
Terry and Sons, Ltd., Herbert, Redditch, Worcs. T: Redditch 61. TA: Springs, Redditch.
Texas Instruments, Ltd., Dallas Road, Bedford. T: Bedford 68051. TA: Texinlim, Bedford.
Thermal Control Co., Ltd., Marine Works, Sackville Road, Hove, Sussex. T: Hove 35929 and 34081.
Thermionic Products (Electronics), Ltd., Shore Road, Hythe, Southampton. T: Hythe 3265. TA: Technico, Hythe, Southampton.
Thermo Plastics, Ltd., Luton Road Works, Dunstable, Beds. T: Dunstable 1444. TA: Thermoplastics, Dunstable.
Thompson Bros. (Bilston), Ltd., Bradley Engineering Works, Bilston, Staffs. T: Bilston 41264. TA: Thompbros, Bilston.
Thorn Electrical Industries, Ltd., Aircraft Components and Connector Division, Great Cambridge Road, Enfield, Middx. T: Enfield 5353.
Tiltman Langley, Ltd., Redhill Aerodrome, Surrey. T: Nutfield Ridge 2232. TA: Airdel, Redhill.
Titanine, Ltd., Sheaveshilt Avenue, Colindale, London, N.W.9. T: Colindale 8123. TA: Tetrafree, Hyde, London.
Titanium Metal and Alloys, Ltd., 2 Metal Exchange Buildings, London, E.C.3. T: Mansion House 4521. TA: Nonfermet.
Torquemeters, Ltd., Ravensthorpe, Northampton. T: East Haddon 232. TA: Torquemeters, Northampton.

ANCILLARY INDUSTRY 1959...

Torrington Co., Ltd., The, Torrington Avenue, Coventry, Warwicks. T: Coventry 74241. TA: Spokes, Coventry.

Transport Equipment (Thorneycroft), Ltd., Thorneycroft House, Smith Square, Westminster, London, S.W.1. T: Abbey 8000. TA: Thorneycroft, Phone, London.

Transport Seating, Ltd., Western Works, Bromley Street, Birmingham 9. T: Victoria 1477 and 1326.

Triplex Safety Glass Co., Ltd., 1 Albemarle Street, Piccadily, London, W.1. T: Hyde Park 8171. TA: Tripsaglas, Piccy, London.

Trist and Co., Ltd., Ronald, Bath Road, Slough, Bucks. T: Slough 25041. TA: Resvalar, Slough.

Trix Electrical Co., Ltd., Maple Place, Tottenham Court Road, London, W.1. T: Museum 5817. TA: Trixadio, Wesdo, London.

Tubes, Ltd., Aston, Birmingham 6. T: Aston Cross 3030. TA: Cylinders, Birmingham.

Tucker Eyelet Co., Ltd., Geo, Walsall Road, Birmingham 22B. T: Birchfields 4811. TA: Eyelets.

Tufnol, Ltd., Perry Barr, Birmingham 22B. T: Birchfields 4554. TA: Tufworks.

Vandervell Products, Ltd., Western Avenue, Acton, London, W.3. T: Acorn 2251. TA: Steelbak, London, Telex.

Vane and Co., A. H, Iando House, Bartholomew Close, London, E.C.1. T: Metropolitan 9201. TA: Avants, Cent, London.

Varley Dry Accumulators, Ltd., By-Pass Road, Barking, Essex. T: Rippleway 3346.

Vaughan and Co., Ltd., Edgar, Legge Street, Birmingham, 4. T: Aston Cross 2071. TA: Compete, Phone, Birmingham.

Vaughan Crane Co., Ltd., The, West Gorton, Manchester 12. T: Manchester East 2771. TA: Vaunting, Manchester, 12.

Venner Accumulators, Ltd., Kingston By-Pass, New Malden, Surrey. T: Malden 2442. TA: Venulators, Phone, New Malden.

Venner, Ltd., Kingston By-Pass, New Malden, Surrey. T: Malden 2442. TA: Cloxwiches, Phone, New Malden.

Vernons Industries, Ltd., Kirkby Industrial Estate, Liverpool. T: Simonswood 3261. TA: Vernex, Liverpool.

Five-foot span, part-sectioned display model of Vanguard for T.C.A., by Westway Models, Ltd.

Tungum Co., Ltd., The, The White House, Arle, Cheltenham, Glos. T: Cheltenham 5855. TA: Cheltenham 5855.

Turner and Co., Ltd., Luke, Deacon Street, Leicester. T: Leicester 22967. TA: Luke, Leicester.

Turner Bros. Asbestos Co., Ltd., Spotland, Rochdale, Lancs. T: Rochdale 4221. TA: Turners, Rochdale.

Turner Electrical Instruments, Ltd., Ernest, Chilton Works, High Wycombe, Bucks. T: High Wycombe 1301.

Turner Manufacturing Co., Ltd., Wulfruna Works, Villiers Street, Wolverhampton, Staffs. T: Wolverhampton 24456. TA: Wulfruna, Wolverhampton.

Ultra Electric, Ltd., Western Avenue, Acton, London, W.3. T: Acorn 3434. TA: Radwaves, London.

Unbrako Socket Screw Co., Ltd., The, Burnaby Road, Coventry, Warwicks. T: Coventry 89471. TA: Unbrako, Coventry, Telex.

United Coke and Chemicals Co., Ltd., (subsidiary of United Steel Companies, Ltd.), P.O. Box 25, The Grange, Treeton. Rotherham, Yorks. T: Woodhouse 3441. TA: Rawmat, Treeton.

United Steel Companies, Ltd., The, 17 Westbourne Road, Sheffield 10. T: Sheffield 60081. TA: Unisteels, Sheffield 10.

Vactric (Control Equipment), Ltd., Vactric House, Sloane Street, London, S.W.1. T: Sloane 9656. TA: Vactrify, Knights.

Vactric (Precision Tools), Ltd., Vactric House, Sloane Street, London, S.W.1. T: Sloane 9656. TA: Vactrify, Knights.

Valay Industries, Ltd., 186 Campden Hill Road, London, W.8. T: Park 8601. TA: Valaypro, Kens, London.

Van Moppes and Sons (Diamond Tools), Ltd., L. M, Basingstoke, Hants. T: Basingstoke 1240. TA: Diatipt, Basingstoke.

Vickers-Armstrongs (Aircraft), Ltd., Weybridge, Surrey. T: Weybridge 5555. TA: Vickersair, Telex, Weybridge.

Villiers (Tool Developments), Ltd., Waddens Brook, Wednesfield, Staffs. T: Willenhall 2252 and 363.

Vinten, Ltd., W., 715 North Circular Road, London, N.W.2. T: Gladstone 6373. TA: Vintacinni, London.

Vokes, Ltd., Henley Park, Guildford, Surrey. T: Guildford 62861. TA: Vokesaceas, Guildford, Telex.

Vosper, Ltd., P.O. Box 18, Portsmouth, Hants. T: Cosham 79481. TA: Repsov, Portsmouth.

W.S. Electronics, 44 Brunel Road, East Acton, London, W.3. T: Shepherds Bush 7601. TA: Seltric, Ealux, London.

Wakefield and Co., Ltd., C. C., 46 Grosvenor Street, London, W.1. T: Mayfair 9232, TA: Cheery, Wesdo, London.

Wakefield-Dick Industrial Oils, Ltd., 67 Grosvenor Street, London, W.1. T: Grosvenor 6050. TA: Dicotto, Phone, London.

Walker and Co., Ltd., James, Lion Works, Woking, Surrey. T: Woking 2432. TA: Lioncelle, Woking, Telex.

Walker (Architectural Decorations), Ltd., James, 15-17 Brunel Road, East Acton, London, W.3. T: Shepherds Bush 2332.

Walter, Ltd., A. J., The Drive, Horley, Surrey. T: Horley 1420 and 4294. TA: Cubeng, London.

Ward, Brooke and Co., Ltd., Westbourne Street, High Wycombe, Bucks. T: High Wycombe 2652.

Warden Aviation and Engineering Co., Old Warden Aerodrome, Biggleswade, Beds. T: Northill 288. TA: Oldwarden.

Waymouth Gauges and Instruments, Ltd., Station Road, Godalming, Surrey. T: Godalming 1330. TA: Waylo, Godalming.

Wayne Kerr Laborotories, Ltd., The, Roebuck Road, Chessington, Surrey. T: Lower Hook 1131. TA: Waynkerr, Chessington.

Wayne Tank and Pump Co., Ltd., Western Road, Bracknell, Berks. T: Bracknell 1600. TA: Wayeoil, Bracknell, Telex.

Wellworthy, Ltd., Stanford Road, Lymington, Hants. T: Lymington 2231. TA: Wellworthy.

Western Manufacturing (Reading), Ltd., The Aerodrome, Reading, Berks. T: Sonning 2351. TA: Hawk, Reading.

Westinghouse Brake and Signal Co., Ltd., 82 York Way, Kings Cross, London, N.1. T: Terminus 6432. TA: Westinghouse, London, Telex.

Westway Models, Ltd., 178 Brent Crescent, London, N.W.10. T: Elgar 3267. TA: Miniatures, London, N.W.10.

Weyburn Engineering Co., Ltd., The, Elstead, Surrey. T: Elstead 2141.

Whitehouse Industries, Ltd. (Philidas Division), Ferrybridge, Knottingley, Yorks. T: Knottingley 2323. TA: Balbearing, Ferrybridge.

Wiggin and Co., Ltd., Henry, Wiggin Street, Birmingham 16. T: Edgbaston 4871. TA: Wiggin, Telex, Birmingham.

Williams and James (Engineers), Ltd., Chequers Bridge, Gloucester. T: Gloucester 24021. TA: Compressor, Gloucester.

Williamson and Son, Ltd., Jas, Lune Mills, Lancaster, Lancs. T: Lancaster 5222. TA: Williamson, Lancaster.

Williamson Manufacturing Co., Ltd., Hawthorn Road, Willesden Green, London, N.W.10. T: Willesden 0073. TA: Kinetogram, London.

Wills Pressure Filled Joint Ring, Ltd., Salmon Parade, Bridgwater, Somerset. T: Bridgwater 4171. TA: Will, Seal, Bridgwater.

Wilmot Breeden, Ltd., Amington Road, Birmingham 25. T: Acocks Green 3344. TA: Bumpers, Birmingham.

Wilson Alloys, Ltd., 114 Nightingale Road, London, N.22. T: Bowes Park 8431. TA: Wilmeta, London.

Wilson and Sons (London), Ltd., 114 Nightingale Road, London, N.22. T: Bowes Park 8431. TA: Wilmeta, London.

Woodside Die Sinking Co., Ltd., Aire Vale Works, Newlay, Leeds 13. T: Horsforth 4251. TA: Wooddie.

Wynn and Co. (Aircraft), Ltd., E. D, Staverton Aerodrome, Gloucester. T: Churchdown 3264. TA: Wynn, Gloucester.

Wynstruments, Ltd., Staverton Aerodrome, Gloucester. T: Churchdown 3264. TA: Wynn, Gloucester.

Xetal Products, Ltd., Speke Hall Road, Speke, Liverpool 24. T: Hunts Cross 2078.

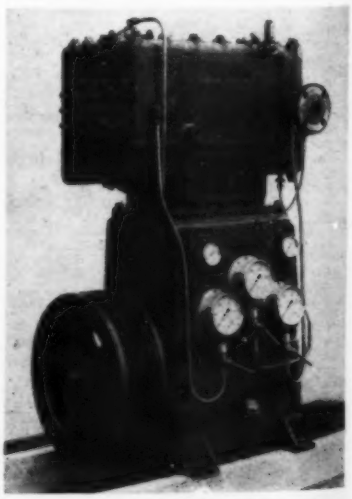
Yorkshire Engineering Supplies, Ltd., Upper Wortley Road, Leeds 12. T: Leeds 638234. TA: Yes, Leeds 12.

Young, A. W., 159 Chatsworth Road, Clapton, London, E.5. T: Amherst 6521.

Z and I Aero Services, Ltd., 14 South Wharf Road, Paddington, London, W.2. T: Ambassador 0151.

Zwicky, Ltd., Buckingham Avenue, Trading Estate, Slough, Bucks. T: Slough 21201. TA: Zwiklim, Slough.

Water-cooled oil-free compressor by Williams and James (Engineers), Ltd. Output : 55 cu ft of free air per minute at 250 lb/sq in



GOING TO FARNBOROUGH

. *General Guidance for Show Visitors*

ABOUT fifty years ago, when S. F. Cody was carrying out his pioneer flying experiments on Laffan's Plain, a contemporary guide thus decorously described the nearby township of Farnborough: "Growing town in Aldershot military district. Farnborough Hill, residence of the Empress Eugenie, is notable for ornate Memorial Chapel to Emperor Napoleon III and Prince Imperial, overlooking railway station. The white cupola of Renascence building is a striking object amid trees on hilltop. Adjoining is a Premonstratensian monastery."

It could hardly have been foreseen then that within a lifetime aeroplanes would come to dominate our lives; that the name Farnborough was to become a synonym for aeronautical research; and that from 1948 onwards the Ministry of Supply airfield at "the growing town in Aldershot military district" would be a mecca for visitors from all over the world, and for the British public in its thousands, at the annual flying display and exhibition organised by the Society of British Aircraft Constructors.

This year's show begins next Monday (September 7) with the now-traditional Press and technician's preview day; and the following three days, Tuesday to Thursday inclusive, are reserved for S.B.A.C. guests. Then come the public days: Friday, Saturday and Sunday, September 11 to 13. All through the week the airfield gates open at 10 in the morning and close at 7 in the evening; but there is a half-hour variation in starting-time for the flying display: on the three public days this begins at 3 p.m.; on all other days at 2.30 p.m.

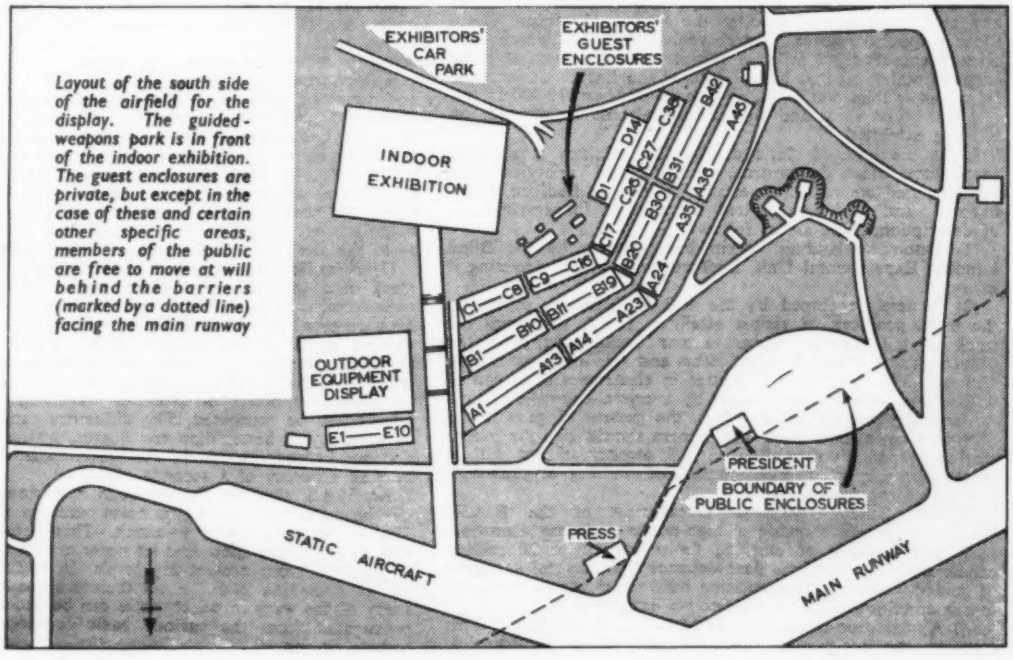
The road to Farnborough in early September is now almost as fabulous as the roads to Samarkand and Mandalay; but although (in a collective sense) the highway forms the most widely used means of getting to the show, it is not the only one. Guests of the S.B.A.C. (especially from overseas) may fly to Blackbushe airfield, whence the Society runs a special coach service to Farnborough for them, operating on the private days and on Friday, first of the public days. It will commute as frequently as possible (e.g., at half-hourly intervals in the busy periods) and guests have only to show their badges or tickets.

For those travelling to Farnborough by train, special facilities are being provided by British Railways. The airfield is well situated near main lines, the Waterloo-Salisbury section passing through Farnborough station and a Waterloo-Portsmouth line *via* Aldershot; in addition a route comes in from Reading and the Midlands to North Camp station. B.R. are this year putting on several special trains, from Cardiff and Wolverhampton, on both the Saturday and Sunday (September 12 and 13) and in addition on the Sunday from Yarmouth, Cambridge and Southend. Extra trains are being run between London and Farnborough and there are special road-rail cheap day tickets from London (which is 9s. return) and other stations to Farnborough and Aldershot. This is done through the co-operation of the Aldershot and District Traction Co. Ltd., who arrange a shuttle service of buses from North Camp and Aldershot stations to points near the airfield. Alternatively, the whole journey may be made by Aldershot and District coach from London. Services leave Victoria Coach Station at 8.50 a.m., and thereafter hourly at fifty minutes past each hour, arriving at Farnborough Town Hall (250 yards' walk from the airfield) about an hour and thirty-five minutes later. The fares for this journey are 4s. 9d. (single), 6s. 9d. (day return) and 8s. (period return).

Having mentioned the cost of coach fares, and the special combined road-rail ticket, it is appropriate to set out the admission costs to Farnborough on the public days. These are more expensive on the Friday, the only day for which advance bookings may be made. Admission charges are £1 for adults and 10s. for children under 14; and parking costs £1 for cars or motor coaches, 5s. for motor cycles and 2s. 6d. for pedal cycles, these payments covering parking only, all occupants of vehicles having to pay normal admission charges. Advance bookings can be made either with Auto-Parks, Ltd. (1 Maclise Road, London, W.14: telephone SHE. 5385-6-7) or through the usual ticket-agencies. Pay-at-the-gates is the form if no advance bookings are made.

Advance bookings cannot be made for Saturday and Sunday (September 12 and 13), when admission charges are 5s. for adults, 2s. 6d. for children (under 14) and 30s. for private cars with up to six occupants. If a car has more than six the extra passengers must pay normal admission charges. Parking fees for motor cycles and pedal cycles on the Saturday and Sunday are 2s. 6d. and 1s. respectively; for motor coaches the fee is 10s., but in practice the parking-space is so taxed on these public days that coaches have to be parked outside the airfield —within easy walking distance, however, of one of the gates.

Many hundreds, if not thousands, of people will be driving their own cars and other vehicles to the air display. For their benefit we reproduce herewith a map showing the main routes

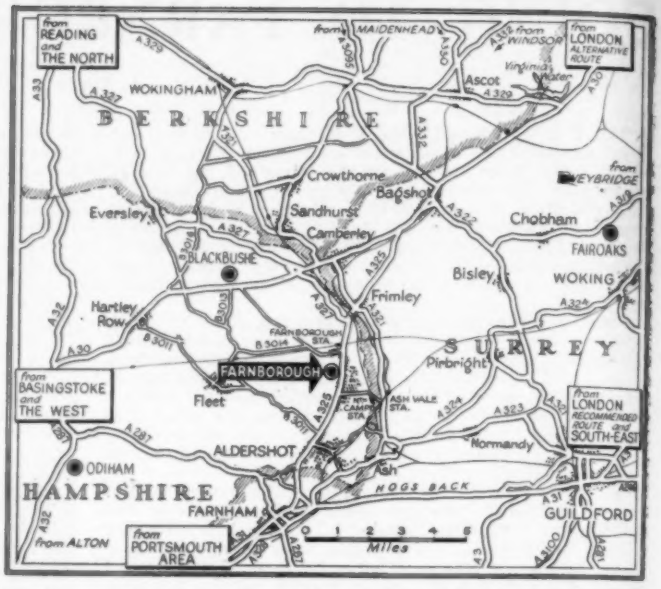


Layout of the south side of the airfield for the display. The guided-weapons park is in front of the indoor exhibition. The guest enclosures are private, but except in the case of these and certain other specific areas, members of the public are free to move at will behind the barriers (marked by a dotted line) facing the main runway

GOING TO FARNBOROUGH . . .

from all points of the compass: from the North, through Reading and down the A327; from London and the South-East, by Guildford and the A31 (Hog's Back), or if coming from London an alternative route is the A30 to Bagshot and down the A325; from the Portsmouth area and the South coast, up the A31 or A325 or A287; and from Basingstoke and the West, along the A30 and A287, then the A325 from Aldershot.

Both the motoring organizations, the Royal Automobile Club and the Automobile Association, are doing all they can to help road-users going to the show. Inside the airfield at Farnborough the R.A.C. will have two mobile offices, manned by "patrolettes" (as the R.A.C. girls are called) and other staff; a radio link is being maintained with Club vehicles patrolling the approach roads; within a 25-mile radius special road-signs will direct drivers, and the R.A.C. is co-operating with the police in putting up temporary signs for the diversion of traffic if necessary. Similarly, A.A. patrols will work closely with the Hampshire police; its officers in the airfield car-parks are again being equipped with walkie-talkie sets; and "Jumbo," one of the Association's big mobile offices, is once more on duty to maintain radio contact between A.A. men inside and outside the display. Both organizations will give motorists assistance in the event of a breakdown, and help the police—who do a splendid job on these occasions—to keep the traffic moving. All such good work, however, depends for success on the co-operation and courtesy of individual motorists. Patience is a virtue on such occasions.



Refreshment, solid and liquid, is obtainable on the show ground, and other amenities include a post office, bookstalls and a generous provision of litter bins (in past years the clearance of litter has been one of the most formidable tasks in the restoration of the airfield for its normal use by the Royal Aircraft Establishment on the post-show Monday).

Footnote: Every year *Flight* is asked, by letter or telephone, "Are cameras permitted?" The answer is yes

M.o.S. WORK ON VIEW

AS is their custom, the Ministry of Supply are again displaying some of their own products in the static exhibition at Farnborough—appropriately enough, for they are officially hosts to this annual S.B.A.C. show held on their own airfield, home of the Royal Aircraft Establishment. Most of these M.o.S. exhibits will be in the indoor display of equipment, but two are being shown outside it, in the guided-weapons park. These are Malkara, the first anti-tank guided-weapon to be successfully developed by the British Commonwealth, officially described as "capable of penetrating the armour of any tank likely to be used in the foreseeable future"; and Black Knight, the space research vehicle, firings of which have already exceeded 500 miles in altitude. The nose section of an experimental head that had re-entered the Earth's atmosphere from higher than 500 miles, at a speed of about 12,000 ft/sec, will also be on view; and typical missile-borne instrumentation is being exhibited.

Inside the covered static display the Ministry is showing seven items which demonstrate the width and variety of work being carried out at M.o.S. establishments—at Bedford, Farnborough and elsewhere. Listed numerically for convenience of description, these are as follows:—

(1) Automatic landing system being shown by the Blind Landing Experimental Unit, Bedford, with a film depicting it in use.

(2) Camera developed by the R.R.E., Malvern, to record the night positions of visible satellites. Fixed, it records the track of the satellite against a star background, with the camera shutter normally open. Stars and satellite show on the film as trails. The camera shutter is electronically closed at half-second intervals determined by a crystal-controlled clock. By omitting pre-selected impulses, the pattern of gaps in the film provides a time chart. The camera should give the individual positions of a satellite to ± 3 seconds of arc with a timing accuracy of 1 millisecond. The limiting brightness is $+5$ to $+6$ magnitude.

(3) The Guided Weapons Department of the R.A.E., Farnborough, are showing a high-power airborne electronic flash unit, capable of emitting flashes of up to 20 million candlepower; an airborne flash-detector unit; several examples of guided-weapon instrumentation built to withstand extremely severe conditions; and a radio-active erosion meter.

(4) A vibration-measuring device will be on show. This employs two finely ruled optical screens which are identical and superimposed. One is fixed, the other attached to the member under observation. Considerable optical magnification of movement occurs and may be viewed stroboscopically or be photographed by ciné camera. Advantages of this equipment are simplicity, compactness and a single light moving part.

(5) The I.A. form tracer, an optical projection system in which successive images of a short section of datum line engraved on a movable transparency appear on the screen. The transparency moves to follow the contour of a component under inspection. Inaccuracies are shown up as the line is displaced from a centre mark on the screen, with magnification of up to $\times 500$ and a range up to 4in.

(6) An apparatus for measuring the accuracy of miniature ball bearings, operating on the principle that the combined effect of all the errors in a bearing will cause the rotating ring to oscillate in radial or axial directions. The bearing is mounted so as to simulate operational practice, and both inner and outer ring may be rotated with different loadings. Oscillations are measured simultaneously by electrical sensing heads and recorded graphically on rectilinear recorders at high magnification. Additionally, the graphs give clear indications as to the cleanliness and quality of the bearing under test.

(7) A radio interferometer used for determination of the track of a transmitting satellite, visible or not, by accurate measurement of R.F. phase difference of signals received at each diagonal pair of four widely spaced aerials placed at the corners of a ground square. These phase differences are directly related to the direction cosines of the instantaneous position of the transmitter at any known time, and if measured on successive orbits of satellites travelling in space enable position to be computed. The difference can be measured to an accuracy of better than one degree, which for a separation distance between aerials of 100 wavelengths corresponds to a bearing accuracy of 6 seconds of arc.

An M.o.S. show at Farnborough requiring reserved tickets will be the film on jet engine noise made by the National Gas Turbine Establishment, Pyestock. This Establishment states that research may show that jet noise can be reduced by about 20 decibels from present-day levels. In addition to its work on jet noise the N.G.T.E. is therefore making a particular study of the ways in which noise can be generated within and propagated from the various basic components of the gas turbine engine.

Il-18 Moskva

IMPRESSIONS OF RUSSIA'S CHALLENGING TURBOPROP TRANSPORT

A MEMBER of "Flight's" staff who was recently able to examine Russia's efficient new turboprop transport, the Ilyushin Il-18 Moskva, has recorded the following impressions.

NOT having myself previously seen the cockpit of the Il-18 turboprop transport I joined a queue bent on doing so, musing that it was remarkably like the queue that seems to be a permanent feature of the approach to the Lenin-Stalin mausoleum in Moscow. This aeroplane is called Moskva, but it certainly is no mausoleum. The structure is clean and modern, with very good flush riveting in most parts, sharply contrasting with a rather rough weather-radar fairing in which the coarsely wrapped honeycomb filling can be plainly seen.

I worked my way slowly inside and was allowed to sit for some time in the captain's seat. The cockpit is a model of its kind. The general background is a fresh pale grey, instrument dials and control panels being black; the blind-flying panels are standard and easily read, with a remote-indicating as well as a gyro-magnetic compass and I.L.S. cross-pointers. There are no fewer than four artificial horizons; one of them is the gyro vertical for the autopilot, arranged like a panel instrument, Sperry-fashion. Two more are duplicate, standard, electrically driven instruments with a bank freedom of ± 60 deg. The fourth is a stand-by instrument with a freedom of ± 90 deg.

Engine-power control is by single levers, each having a manually operated trip catch to release a flight-fine-pitch stop on the quadrant. Forward of these are the feathering buttons and fuel-pump controls and above them, on the central panel, are the main engine instruments. Two banks of dials show engine r.p.m. and torque, while four fuel-flow indications are on paired dials, together with two fuel gauges which presumably indicate the total amount in each wing. On the rear of the central pedestal are the three trim-wheels and indicators, and the control box for the electric autopilot which operates the controls through hydraulic jacks. The usual flight-control features are included, but there is no coupling for automatic approach or radio-course-holding.

On a swivelling mounting in the middle of the windscreen are twin scopes for the weather radar, which is apparently used as a primary navigation aid both for mapping and for estimation of drift. The actual tube controls are next to the scopes, but the remainder are in a small black panel in the roof, within comfortable reach of both pilots. Range settings of 50, 120, and 240 km (31, 75 and 150 miles) are available. The standard Russian radar altimeter is carried, together with V.H.F. communications radio, an H.F./M.F. receiver next to the co-pilot and two A.D.F.s in the roof with frequency bands ranging from 150 to 1,300 kc/s. Though, according to my Russian guide, this was all the radio equipment on board, it would hardly seem to justify the carriage of a specialized radio operator unless C.W. radio were also used. He had heard of Decca, but only smiled and shrugged when I asked whether a similar aid existed in Russia.

The pilots' seats themselves were adjustable and comfortable, leaving plenty of room for access and with good visibility through the windscreen. Normal air-conditioning was supplemented by two rubber-bladed fans, one close to each pilot. The control columns themselves were mounted outboard and carried over in front of each pilot, the tiller wheel for nosewheel steering being mounted in the column elbow. Pendant rudder pedals carried toe-operated brake segments. The main control wheel itself had a series of buttons serving, from right to left, nosewheel-steering engagement, autopilot disengagement, V.H.F. press-to-transmit and intercom. press-to-speak. This last, I felt, was a curious device; and another was an electric control-locking system, operated by a switch on the central console. Incidentally, flap extension causes a pronounced nose-down attitude and the Il-18 touches down nosewheel-first.

I moved back into the passenger area. Farthest forward was a well-appointed 15-seat cabin, probably for first-class passengers. Immediately aft was a long section housing coat-hanging space and galley—located, significantly, in way of the four propellers of the Ivchenko 4,000 h.p. engines. Aft again was the main cabin with thirteen rows of five-abreast seats. The general impression was one of cool good taste, with pale grey the dominant colour, though everything was pervaded by a bitter smell—like a lavender floor polish gone wrong—which I think came from plastic furnishing material. The finish seemed very good, but there was an annoying quantity of unrealistic artificial wood in the plastic window-surround mouldings and bulkhead facings. Narrow strips of green carpet down the aisles were also of poor quality, and the neat curtains, which could be slid over the windows, were of a rather sickening purple. Despite these jarring notes, the *décor* as a whole was excellent, the main colours being well matched. It was like a breath of fresh air after a Tu-104 cabin of the original Tupolev vintage.

As far as I could see, oxygen was not supplied to each seat, but there were several large cylinders of it in racks next to the sliding main entrance at the rear. Opposite was an enormous couch, which the stewardess said was for passengers who felt ill. Further coat-hanging space here was topped off with two large and well-equipped washrooms and toilets, including rest seats, electric-razor points and big mirrors.

This particular Il-18 was registered CCCP-75686 and bore the additional number—the genuine constructor's number—189001201 on the base of the fin. A crew-member said that they had flown non-stop from Moscow to Paris in 4 hr 15 min, at a groundspeed of 660 km/hr (412 m.p.h.). A notice stated that the Il-18 could carry 75 to 100 passengers, cruising at 650 km/hr (407 m.p.h.) at 8,000m (24,300ft) with a range of 5,000 km (3,120 miles) plus one hour's reserve. Payload was 14 tonnes (30,800 lb) and gross weight varied between 51 and 64 tonnes (112,200 and 140,600 lb).

C. M. L.

In heading, Il-18 with Mi-4. Below, Il-18 at Paris

Among the light aircraft on view at the World Congress of Flight at Las Vegas earlier this year none was smarter than the new Morrisey 2150, produced by Morrisey Aviation Inc. at Orange County Airport, Santa Ana, California. The 2150, two of which are here seen in formation, is an all-metal, 150 h.p. Lycoming-powered successor to the fabric-covered 90 h.p. Nifty. Over a dozen of the new type have been produced, at a selling price of $7,885 (approx. £2,800)

Sport and Business

QUEEN BEE is the name of the third aircraft to be developed by Bee Aviation Associates Inc. of San Diego. Successor to the diminutive Wee Bee and the Honey Bee (see photograph), the new machine has completed initial F.A.A. airworthiness tests and may be put into production in Australia and the U.S.A. In addition to the first prototype shown, two further prototypes are to be built by the Bee company, which is a development organization and does not itself intend to manufacture a production version.

Powered by a 160 or 180 h.p. Lycoming engine, the Queen Bee is of metal and glass-fibre semi-monocoque construction and incorporates a vee-tail. Of particular interest is the dual control system, which comprises a single central control column and separate throttles in place of the more usual central throttle with twin control columns. Fuel capacity is 42 U.S. gal, all carried in the glass-fibre wingtip pods.

Leading Queen Bee data include span, 32ft; length, 21ft 10in; empty weight, 1,190 lb; gross weight, 2,150 lb; cruising speed, 155 m.p.h.; range, 650 miles; take-off, 950ft; landing, 700ft.

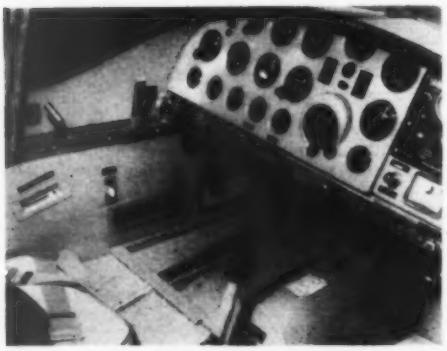
COMMITTEE MEMBERS elected at the recent annual general meeting of the Popular Flying Association comprise A. Cdre. G. J. C. Paul, N. H. Birch, C. J. de Vere, J. Howell, R. McHardy, F/L. H. B. Iles, G/C. J. A. Kent and F/L. A. T. Warburton. Col. R. H. Preston has resigned from the committee, which is chaired by the P.F.A. chairman, Harold Best-Devereux.

RETROSPECT

From "Flight" of September 4, 1909

Club House at Shellbeach Flying Ground: The Committee of the Aero Club are proposing to take over Muscle Manor for a Club House on the flying ground. In order that this may be effected, and in view of the very large expenditure which has already been made at Shellbeach, the Committee appeal to the Members for special subscriptions for this purpose. The Golf Course will be taken over for the use of Members, together with the shooting rights extending over 1,000 acres.

Hive of bees: the lower photograph shows the Wee Bee, Honey Bee and the new Queen Bee, all produced by Bee Aviation of San Diego. The Queen Bee (upper views) has an unusual dual-control arrangement of central stick and twin throttles



Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

British Light Aircraft Overseas

ROGER BACON, in "Straight and Level," mentioned the lack of a British light aircraft for overseas operation. But the illustration he gave was of a "Service"-type requirement, where aircraft presumably are flown by full-time pilots. The light aircraft market, if there is one, should be based on a "self-drive" aircraft.

Apart from price, light aircraft seem mainly to be judged on their "flyability," short take-off performance and so on. I suggest that there are other important considerations which control development.

Thus a reasonable road system probably gives a door-to-door speed for a car of about 50 m.p.h. Therefore a light aircraft to be competitive should cruise at between 150 and 200 m.p.h., and this is possibly borne out by the experience of operators of scheduled air services. On this count current British light aircraft are not competitive except where ground communications are poor or, say, a water crossing is involved. On the other hand a STOL characteristic is probably very useful.

Prospective purchasers must necessarily consider their maintenance arrangements. Abroad it is apparently usual for owners to make their own arrangements by combining in clubs if necessary. Much of the success of car sales abroad is due to the effectiveness of the maintenance organization available and at one time I was advised only to buy certain specific makes for this reason. Light aircraft manufacturers might well consider appointing agents overseas who would provide some maintenance organization, possibly in conjunction with some other engineering business.

A pilot must learn his flying somewhere. Abroad it may be difficult to combine with a view to organizing training facilities. I have had to rely almost entirely on the assistance of honorary instructors, and I am most grateful for their assistance. Nevertheless, with such rather limited instruction facilities people are not likely to become light-aircraft-minded. I suggest then, that attention should be given to making people air-minded. As it is difficult to provide instruction facilities overseas it must be borne in mind that at least a proportion of the people likely to be interested do visit the United Kingdom and they may then be more easily reached.

Lastly there is the very important question of cost, and some reduction in efficiency might well be acceptable if the first cost or maintenance costs could thereby be reduced. On the other hand some of this high cost must be recouped from the use to which one puts the time saved by flying, which is again a question of people becoming light-aircraft-minded.

Alor Star, Malaya. W. P. WINSTON.

Blackbushe and Gatwick

IN your issue of August 21 you report the Ministry decision to close Blackbushe Airport. After the fiasco over Croydon Airport it is evident that, whatever views are put forward over the rightness or wrongness of a Ministry decision, the decision, once made, is forced through. Therefore it is inevitable, presumably, that Blackbushe will close. There are two or three points, however, which should be raised before the axe falls, and one wonders if the Ministry has given them due consideration.

It is understandable that after all the millions that have been put into Gatwick the Ministry will insist on its being used as L.A.P.'s main diversion airfield, and rightly so. But in the old days Gatwick's big bugbear was flooding; this may not affect the new airfield, but it has yet to be proved. Since Gatwick came into operation we have had one mild, dry winter and whether or not the airfield will succumb to a normal English winter remains to be seen. Further, we have not had sufficient experience to prove whether the airfield will be adequate to cope with all the increased traffic which is expected in the next few years.

Despite the increasing executive traffic to and from the Continent, Croydon has been closed; and this type of traffic is not catered for by the large and busy airfields with their conglomeration of scheduled services. By contrast the atmosphere and more intimate "processing" available at fields such as Blackbushe are more in line with this type of traffic. The figures you quote on p. 57 of your August 21 issue show that a large proportion of Blackbushe's transport traffic is of this nature.

It is interesting to speculate whether any airline pilots have been consulted over the decision. Surely one of the most important factors in a diversion airfield is that of pilot-suitability, and it would be interesting to hear the views of pilots who have used both Blackbushe and Gatwick. My own piloting days are over, so I cannot speak with authority on this point; but I have seen few airfields near London to match Blackbushe for clear and unobstructed approaches, probably the most important single factor in bad-weather flying.

The final point worth considering is this question of cost. It is stated that it would require £2m to bring Blackbushe up to the necessary standards for modern transport aircraft. But it has been proved that the airfield can be used by all current aircraft with the exception of, probably, the Boeing 707 and Douglas DC-8. And for several years yet these aircraft will form the minority of the aircraft flying in and out of London. In the case of emergency Blackbushe could still take the main burden of L.A.P. in the event of Gatwick being "out" also. And whilst on the question of cost it seems madness indeed that over £50,000 of the public's money should have been spent, within the last year, on enlarging Blackbushe Airport's terminal building and making other airfield improvements. Surely, when the Ministry put these works in hand, it must have known that it was going to close the airport about 18 months later.

One realizes the Ministry's laudatory intentions of saving the taxpayer money and its desire to justify its latest creation at Gatwick; but one cannot help feeling that the retention of Blackbushe, if only for a period of five years, would be an act of foresight and wisdom, even if it was retained in its present state without the expenditure of £2m. By then we would know for certain whether Gatwick is really weather-worthy at last and whether L.A.P. and Gatwick between them are able not only to cope but to provide the right kind of facilities for the increases we all expect to see, not only in scheduled services but in freight, inclusive-tour, charter and executive traffic, within the next few years. Even as I write this, however, I realize that it is almost certainly futile: no surer indication of the Ministry's firm intention to close Blackbushe can be seen than the aforementioned enlarging of the terminal there. It fits in the traditional pattern only too well.

Farnham, Surrey. JOHN D. R. RAWLINGS

Preserving Early Aircraft

WE were most interested in the article "Registering the Famous" in your issue of August 21, and we feel that your readers may be interested in some amplification of the information contained therein.

The Avian IIIA, previously in the custody of Mr. Murphy at Stockport, was registered G-EBZM and was built in 1929. The aircraft was under reconstruction at Ringway until the closure of the Eagle Aviation maintenance base there earlier in the year, when the machine was "presented" to the airport fire service. Fortunately the Merseyside Group of Aviation Enthusiasts was able to rescue it before it could be burnt, and it was moved to a place of storage near Liverpool on April 5; however, during its last days at Ringway it suffered from the attentions of both the Mancunian weather and certain local "aeroplane spotters" and is now beyond restoration to flying condition.

The Avian G-ACGT is also still in existence, having been stored for some years in Yorkshire. This machine was also built in 1929, having previously been registered in Eire as EI-AAB (the old Irish registration still being faintly visible underneath its British marks), and is fitted with a Genet Major 1A radial engine.

Other minor points concern the F.A.A.'s Swordfish, the serial of which is NF389 (although it is now painted differently for the film *The Sinking of the Ark Royal*); the Spitfire XI at Old Warden, which is PL983 and has also flown under U.S. ownership as N74138; and the Spitfire 1 at Old Warden, which is AR213, a Westland-built aircraft. The Spitfires R6915 and X4590 are Mk 5A, not Mk 1; and the Shuttleworth Collection Avro 504 is E3404.

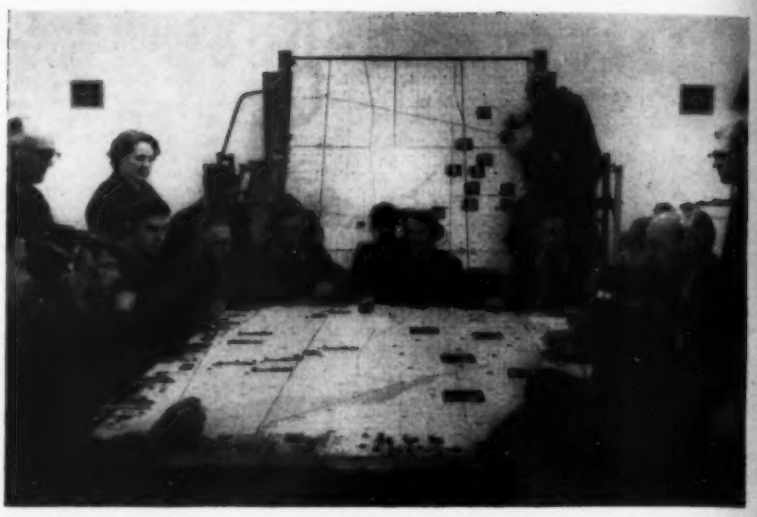
Liverpool 7. P. H. BUTLER,
Hon. Secretary, Merseyside
Group of Aviation Enthusiasts.

FORTHCOMING EVENTS

Sept. 5-6. British Women Pilots' Association: Flying Weekend.
Sept. 7-13. S.B.A.C. Display and Exhibition, Farnborough.
Sept. 10. Helicopter Association: Annual Dinner.
Sept. 11-13. German Aero Club: Rally, Baden-Baden.
Sept. 13. Newcastle-upon-Tyne Aero Club: At Home, Woolsington.
Sept. 14. Institute of Transport: Brancker Memorial Lecture, "World Peace through Air Transportation," by Capt. E. V. Rickenbacker.
Sept. 15. Battle of Britain Day.
Sept. 19. International Spherical Balloon Concours, Zurich.
Sept. 20. British Gliding Association and London Gliding Club: National Glider Aerobatic Contest, Dunstable.
Sept. 23. R.Ae.S. Graduates' and Students' Section: Film Show.
Sept. 24-25. AGARD: Ninth General Assembly, Aachen.
Sept. 24-25. Aerodrome Owners' Association: Conference, Bristol.
Sept. 26-27. Genoa Aero Club: Rally.
Oct. 4-16. Seventh Anglo-American Aeronautical Conference, New York.
Oct. 6. IATA: Dr. Albert Plesman Memorial Lecture. "Supersonic Flight," by Hall L. Hibbard, at Delft, Netherlands.

SERVICE AVIATION

Royal Air Forces and Naval Flying News



Royal Observer Corps members at work in the underground operations room at the new headquarters of No. 12 Group (Bristol), R.O.C. This new centre, the first to be constructed in England, was opened by Mr. Airey Neave, Under-Secretary of State for Air, on August 22

Air Council Posts

TWO new appointments to the Air Council have been announced. Air Marshal Sir Arthur McDonald, at present A.O.C-in-C. Technical Training Command, is to be Air Member for Personnel from October 1; and A.V-M. S. C. Elworthy, Commandant of the R.A.F. Staff College, becomes D.C.A.S. (with the acting rank of air marshal) on November 15. He succeeds Air Marshal Sir Geoffrey Tuttle, who is retiring from the Royal Air Force.

Planning the "At Homes"

SOME idea of the complex planning needed to co-ordinate R.A.F. and U.S.A.F. aircraft movements to and from Battle of Britain displays on September 19 has been given by Air Ministry. About 150 machines are involved and it is estimated that in visiting thirty-one stations "at home" to the public they will travel something like 45,000 miles in three hours. In addition, about six hundred Service aircraft will be on static show or giving displays at individual airfields.

Arranging and controlling the 50 formations into which the touring aircraft will be split, and ensuring the safety of civil and other military aircraft flying at the same time, is the responsibility of Fighter Command headquarters, assisted by Commands and Groups throughout the country. Once the latter have said what aircraft they will have available for "at homes," and what kind of show each can give, routes and visits are worked out. Much assistance is provided by, and the closest liaison maintained with, the M.T.C.A.

Typical of the problems are the widely differing speeds of participating aircraft, safe flying heights (for example, for a Vulcan flying across Snowdonia from Valley and having to be below airways height before reaching Cosford in Shropshire) and dovetailing with civil traffic patterns.

Naval participation in next week's S.B.A.C. display at Farnborough will be provided by Scimitar F.1s of No. 807 Sqn., which is commanded by Lt-Cdr. K. A. Leppard, R.N. It was the second Scimitar squadron to form (in October last year), has been working up at R.N.A.S. Lossiemouth and is due to go to sea in H.M.S. *Ark Royal* early in the new year. *Flight* air-to-air pictures of the squadron's aerobatic team were published on June 19 and August 14.

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The eleventh reunion of M.R.E.S. Officers' is to be held on Saturday, October 31. Full particulars may be obtained by writing (with a stamped, addressed envelope enclosed) to S/L. P. E. Laughton-Bramley, M.B.E., 18 Cadogan Place, London, S.W.1. (Telephone: BEL. 3550.)

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Officers from the R.A.F. Staff College, Bracknell, visited the Royal Netherlands Air Force base at Eindhoven on July 24 as part of a study tour of NATO air bases in Europe.

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Two postings to the Queen's Flight at R.A.F. Benson have been announced. G/C. T. N. Stack has been appointed Deputy Captain and W/C. R. G. Wakeford, Commander. G/C. Stack has been Group Captain i/c. Operations (Transport Support) at Transport Command headquarters since 1957 and W/C. Wakeford has recently completed a course at the R.A.F. Flying College, Manby, on all-weather jet flying. Prior to that he was seconded to the Malayan Government as Director of Operations.

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G/C. C. H. Simpson, who has commanded R.A.F. Eastleigh since June last year, is to assume the new post of Senior R.A.F. Officer East Africa from September 15 with the rank of air commodore.

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The R.A.F.A. Motor Club (north-west division) is holding its annual Battle of Britain Rally on September 12 and 13. Club headquarters are at Alton House, Shrewsbury Road, Oxton, Birkenhead.

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The R.A.F. won the Inter-Services Swimming Championship at Eltham, Kent, on August 25 for the eighth successive year. They scored 80 points against 36 for the Army and 34 for the Royal Navy. The W.R.A.F. won the women's championship.

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No. 52 Sqn. has disbanded its headquarters at R.A.F. Changi, Singapore, which has been its base since July 1947; but the half of the squadron at R.A.F. Kuala Lumpur is continuing as the remnant of the Air Supply Force (Malaya), whose functions are gradually being taken over by the Royal Malayan Air Force. S/L. S. R. Dixon, who commands the Air Supply Force, has taken over command of No. 52 Sqn. at Kuala Lumpur from S/L. D. G. F. Palmer.

A.V-M. P. S. Blockey (second from left, below), recently appointed S.A.S.O. of Technical Training Command, seen with his three sons who are all R.A.F. officers. From left to right, John W. (F/O., with No. 207 Sqn.); Robin S. (F/L., A.D.C. to the A.O.C. No. 18 Group) and his twin brother Peter D. (F/O., with No. 54 Sqn.)

Pilots from R.A.F. Germany who recently took part in the annual AIRCENT air firing competition at Cazaux, the French Air Force base and test centre. From left to right, F/O. P. G. Alston, F/L.s R. I. Stuart-Paul and R. de V. Boult (team captain), F/O. M. S. Davis and F/L. J. McVie. Behind is a Hunter F.6